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INSTRUMENTS

INDUSTRIAL — SCIENTIFIC

Devoted to the Instrument Problems of all Industries

Vol. 1. No. 9 Pittsburgh, Pa. September, 1928

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Birmingham, England

A New Engine Indicator.
Max Hartenheim, Pittsburgh, Pa.

The Calculagraph.
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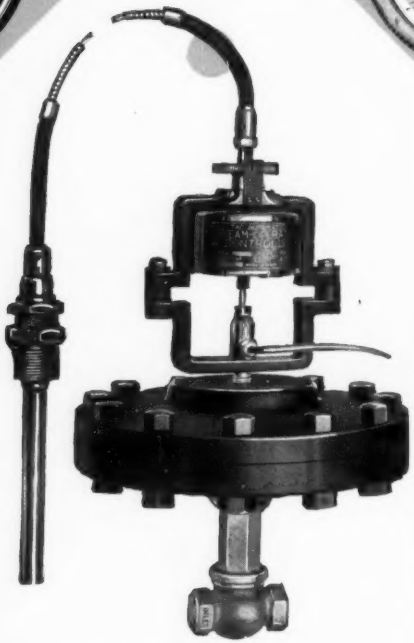

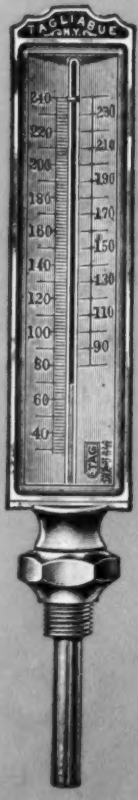

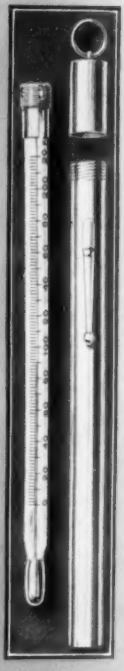

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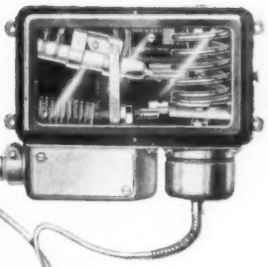

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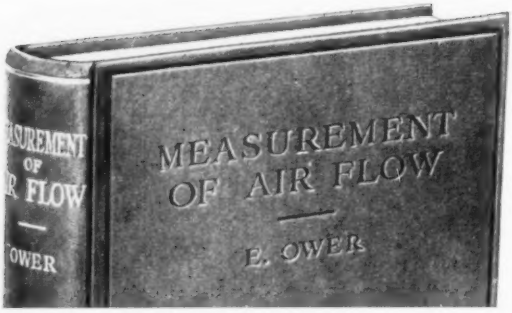

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E. Ower, B.Sc. (Lond.), Hons. I., A.C.G.I.

Bramwell Medallist; Member of the Institute of Heating and Ventilating Engineers; Assistant in the Aerodynamics Department, National Physical Laboratory.

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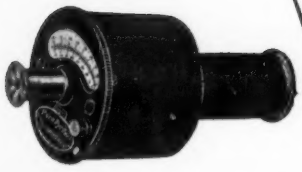

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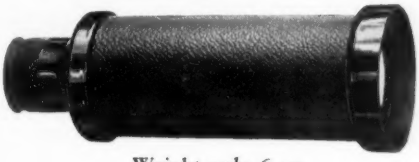

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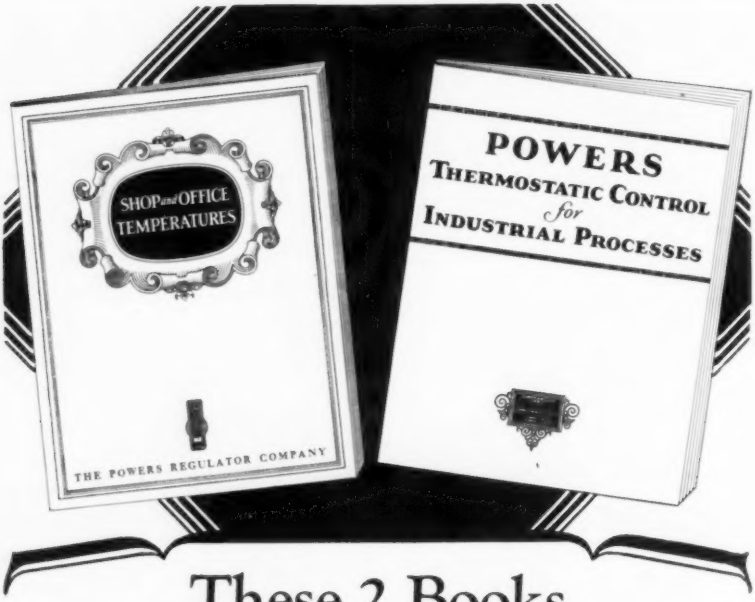

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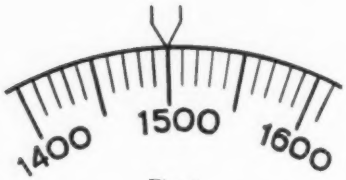

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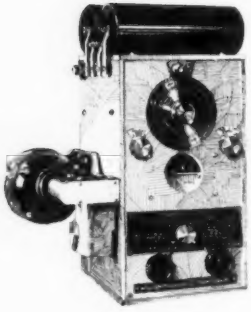
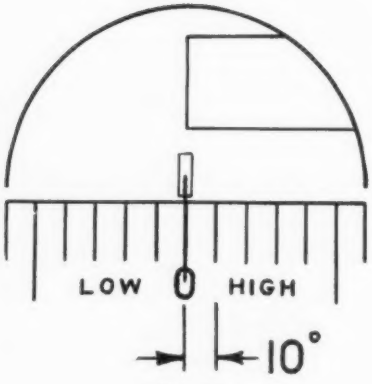


Fig. 2



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Vol. 1 No. 9 SEPTEMBER 1928 Pittsburgh, Pa.

To Our Readers

CONTINUING in our efforts to be of maximum service to the instrument users and instrument manufacturers of the United States, we have been successful in obtaining the cooperation of Mr. E. H. McClelland, Technology Librarian of the Carnegie Library of Pittsburgh. This cooperation promises to concentrate at Pittsburgh the most complete collection of information on instruments, measurements, tests, etc., in the United States.

To the great fund of information on this field which the Technology Department of the Library already has, INSTRUMENTS adds its bit by placing there a number of foreign publications, especially instrument journals, which the Library does not at present receive.

This arrangement further offers an advantage to INSTRUMENTS' subscribers in that any material in the Technology Department of the Carnegie Library of Pittsburgh may be copied at cost.

Every effort is also being made to round out the book collection available in the Carnegie Library, in this unique but important field, so that all available material may be at hand. It is not generally realized that there are some five hundred books on instruments, measurement, inspection, control, etc. A list of these has been compiled and will be published in a future issue of INSTRUMENTS as there is no existing bibliography of the subject.

In very special cases individuals searching for instrument information may find it profitable to come to Pittsburgh.

——— :: ———

Have You Subscribed to Instruments?

EXTRACT from a letter received by one of our advertisers:

"We very much appreciate your letter of August 2nd, giving us the names of companies manufacturing a recording calorimeter. It was indeed kind of you to go to so much trouble. We are familiar with the little magazine "INSTRUMENTS" and although we do not personally subscribe to it, we do see copies of it occasionally."

The above letter with the following notation was received by the editor:

"Apparently, engineers in many plants where you circulate 'INSTRUMENTS' take it for granted that some plant official has sent in the subscription and they need not bother. You ought to broadcast a letter saying that whoever is interested should ascertain whether his company *has* subscribed—or better still, should subscribe personally."

These extracts plainly show the service which INSTRUMENTS performs. No special campaign has so far been necessary. The suggestion "*whoever is interested should ascertain whether his company has subscribed—or better still, should subscribe personally,*" should be followed by all those who have at some time or other seen copies of INSTRUMENTS.

Our subscription campaign assures each one on our list of receiving three sample issues of INSTRUMENTS unless a subscription has been received. These three sample copies are not sent in any regular order or regular intervals and you, therefore, may miss very valuable information by failing to assure a copy regularly passing over your desk. To be absolutely certain that you will see INSTRUMENTS regularly send us your subscription on the enclosed subscription blank bound in back of each issue. One year $2.00, two years $3.00.

You may not desire instrument information today but when you do, the value of your copies of the periodical cannot be measured in money. Each issue of INSTRUMENTS places at your disposal:

1. the editorial staff and collaborators of INSTRUMENTS
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4. Information Section Service, which furnishes information on the manufacture of certain instruments
5. the Catalogue Library, which each month lists the new literature issued in that month
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8. lists of all instruments patents granted in England, Germany and the United States
9. index cards covering the articles appearing in INSTRUMENTS
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If you are not a subscriber, why not enclose your check for a two year subscription—NOW!

The Present-Day Trend is Toward Specialization

DUE to rapid advance of engineering and science, it is becoming very difficult to arrange the current literature covering the various phases for easy access. The trend in the past has been toward comprehensive publication, while the present day trend is toward specialization.

This latter trend in favor of segregation is shown in the new Bureau of Standards Journal of Research, consolidating the separate Scientific and Technologic Papers.

The same is true of the trade papers. More and more the trade paper is becoming a specialist. This permits covering the subject adequately and helpfully.

——— :: ———

Series of Articles on Practical Testing of Varnishes, Compounds, Paints, Enamels, Etc.

WE below reprint a letter received from Mr. H. L. Hazeltine, one of our collaborators.

DEAR MR. RIMBACH:

As promised you recently the writer is preparing a series of articles for your publication covering the subject of the practical testing of varnishes, compounds, paints, enamels, etc. The first of this series which should be ready for either the October or November issue will discuss instruments and methods used in the determination of flashpoint.

In order that future articles may be of as much universal interest as possible, could your readers not be induced to suggest similar topics that will be of most help to them?

Yours very truly,

H. L. HAZELTINE,
Engineer of Insulation,
Sterling Varnish Company.

Mr. Hazeltine is especially qualified to prepare this series of articles and we announce this series with the knowledge that the information contained therein will be the latest word on this subject.

The editor desires to point out especially that Mr. Hazeltine states the series will cover the "practical testing of varnishes, compounds, paints, enamels, etc." This most certainly should arouse the "universal interest" of INSTRUMENTS' readers.

The editor would therefore appreciate receiving suggestions from the readers as to the topics which hold especial interest for them. Address your letter to the Editor, Instruments Publishing Company, 1117 Wolfendale Street, Pittsburgh, Penna.

The men who see this issue for the first time will not want to miss a single installment of this series—therefore, be sure to send in your subscription on the blank, bound in the back of this issue.

Conservation of Our Water

PROBABLY nowhere is there such waste of natural resources as in our own country, and such waste is permitted to continue. This is especially true in regard to water. The prevailing idea being that water being available it should be used regardless of the supply or the cost of making it available.

The power plant of the pumping station is usually a source of considerable waste. A survey of the plant will usually disclose some or all of the following: Improper firing, dumping of unburned coal with ash, defective grates, leaky boiler settings, scaly and sooty tubes, improper insulation of steam pipes, etc. Instruments for checking and controlling the various functions of the plant will materially reduce these losses.

Another heavy loss of water is through leakage. The destruction and damage to water mains, leakage of joints, dripping outlets, etc., may cause large losses that are not easy to locate. District meters and house meters form a system for detecting leaks. Even where meters are used, periodical inspection will bring to light losses not registered by meters.

An estimate of the approximate loss of water from various sources is 20% of the volume originally supplied to the mains. The cost of supplying 20% of the water to be wasted is just as great as the cost necessary to supply another 20% which is used.

At home or in the plant appoint yourself a "committee of one" to prevent water waste.

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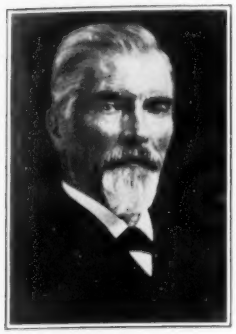
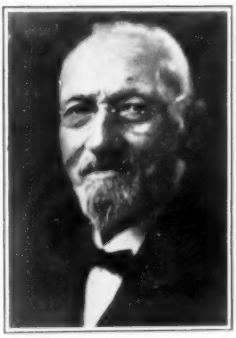


Capt. Henry Lomb
(1826-1908)

Instrument Pioneers



John Jacob Bausch
(1830-1926)

THE story of these two pioneers is in reality the history of the Bausch & Lomb Optical Company, which this year is celebrating its Seventy-fifth Anniversary.

John Jacob Bausch was born at Süssen, Württemberg, Germany, on July 25th, 1830, to George Bausch and Annie Schmidt. He received his early training as an optician in the village of Greuss. This he obtained only by a great sacrifice on his own part and on the part of his parents. His mother died when he was very young; and during an epidemic of typhoid fever, to which nearly the whole family succumbed, his father died. While John Jacob Bausch was getting back his strength his mind revolved the prospects which the future held for him if he were to remain in the little town where he was born and where his ancestors had lived. So he announced his resolution to find opportunity somewhere else as an optician. A little later he heard that there was a chance for an optician in Berne, and very much against the wishes of his family he shouldered his knapsack and set out on foot.

When he arrived at Berne, he found that the opportunity awaiting him was indeed not great, and for some time he lived by making spectacles and selling them. He was able to make six pairs a day and sell them at six cents a pair. Since this did not afford him a living he returned to his home, obtained some money and took passage for America. After a stormy voyage lasting forty-nine days he arrived in New York Harbor.

Henry Lomb was born in Burgham, Hesse-Cassel, Germany, on November 24, 1826. He was driven out of Europe by the prevalent hard times in the early nineteenth century, setting off for America in 1849, the same year in which Bausch started on his emigration.

New York in those days considered itself so crowded that one without financial means could have little chance there; and John Jacob Bausch was advised to seek his fortune in the West. He took this advice and went to Buffalo.

His entrance into Buffalo was hardly encouraging; for he arrived in that city while it was in the midst of the cholera epidemic. He found that there was no call for opticians in Buffalo. The pioneer of Western New York had not strained his eyes pouring over books, working in offices, and sitting for hours in the glare of bright artificial lights. Furthermore, people did not appreciate the necessity of protecting their vision with properly ground and fitted glasses. So Bausch had to find employment in any job that offered. At last becoming somewhat discouraged by the prospects offered in Buffalo he borrowed $5.00 and set out for Rochester.

Rochester at that time, 1838, was a village along whose muddy streets pioneer wagons drawn by oxen travelled slowly. Bausch found employment as a wood turner. He worked at this until the year 1852 and prospects looking rather rosy, he married Barbara Zimmerman in 1853. Seven weeks after his marriage his hand was injured in a buzz saw necessitating the amputation of two of his fingers.

Bausch afterward said that he regarded his misfortune as the crucial moment in his life. It was during those weeks of inactivity that the friendship between him and Henry Lomb ripened through the aid which Lomb and other friends of Bausch gave him. Had it not been for Henry Lomb and these friends Bausch would have had difficulty in weathering this period of unemployment. Also during this time he resolved to return to his trade as an optician. He had no funds. Henry Lomb, being thrifty and single, had saved $60.00.

"Lend it to me," said Bausch, "and when my business grows large enough so that it can support us both you shall have a half interest." These simple words were sufficient articles of partnership for these two friends. In 1853 John Jacob Bausch set up a shop in the gallery of Reynolds Arcade. The stock was purchased in Germany and included spectacles, thermometers, field glasses, telescopes, magnifiers, opera glasses, microscopes and hour glasses.

A little later he was able to move to the more favorable ground floor location at 20 Arcade. It is interesting to note that this shop was always more than just a retail establishment. Records indicate that it was a laboratory, a workshop and a miniature factory all in one. Lenses were ground by hand from the first. Frames of various kinds were made and repaired.

At the outbreak of the Civil War, Lomb enlisted as a private, returning in 1863 a Captain in the company in which he had enlisted. During his service at the front, it is noteworthy that he contributed to the support of the company out of his meager soldier's earnings.

It was during this period that Bausch happened to pick up a piece of hard rubber on the street one day. He got the idea from this that it might make good material for optical goods and frames. Experimenting

showed that he was correct in his surmise, and the sole rights were obtained from the Goodyear Rubber Company for the manufacturing of optical rubber goods in America. Although the work of preparing the hard rubber so that it could be used in manufacturing optical goods was strenuous, requiring that the family arise at an early hour to soften the rubber over the kitchen stove, the work went on to such good purpose that when Lomb returned, Bausch was able to show him a bank balance of $800.00 with all the partnership debts paid.

The following year, 1864, the business moved a step forward and the partners were able to take factory space in a building at the corner of Andrews and Water Streets. The firm was doing business at that time under the name of the Vulcanite Optical Instrument Company. An office of the company was opened in New York City at 182 Broadway by Lomb.

Because the expanding manufacturing business involved so much of their time the partners sold their retail business to E. E. Bausch the brother of John J. Bausch. Four years later they took over the building at River and Water Streets. While in the River Street factory, Bausch invented and applied the first nosepiece to an eyeglass, and his sample make in the 60's embodies many principles which have since been applied in the present construction of eye glass frames, nosepieces, springs and guards.

The next move after quitting the premises at the corner of River and Water Streets was into their own factory home, a brick building erected on the present site of the Bausch & Lomb Optical Company at St. Paul Street and Vincent, now Smith Street. This property was purchased by the company now doing business under the name of Bausch and Lomb Optical Company.

In 1875, the company began the manufacture of microscopes. A year later the model which it had created was exhibited at the Centennial Exhibition at Philadelphia. It made a very favorable impression among the scientific men who examined it. The great ambition of Bausch and Lomb Optical Company was to create a microscope, scientifically accurate, of the best quality in workmanship, to be sold at a price so that it could be used generally by medical men and as an accessory in teaching biological and other sciences.

Not only were there the difficulties natural to manufacturing a high grade article at a reasonable price, but also the even greater difficulty founded in the opinion then wide spread and firmly established in the public mind of America, that optical goods of real worth could not be made in this country, but must necessarily come from Europe.

It may be truthfully said that the standard of turning out skilled work on true scientific principles found its inception at this time. The Bausch and Lomb Optical Company points with pride to the fact that it was

able to so perfect an organization that it could make optical instruments of a quality to pass the examination of American scientists.

It was not until the year 1890 that the Bausch and Lomb Optical Company began to bring in real financial returns. In this year, also, it became associated with Carl Zeiss Company in Jena, Germany. Bausch and Lomb were the first to manufacture practical commercial anastignant photographic lenses.

The next year Bausch and Lomb began the manufacture of Stereo Prism Binoculars. More floor space was obtained by the addition of a story on the first factory building. This year also, the Bausch and Lomb Microscope won a prize at the International Exposition Universelle, Paris.

In 1903 William Bausch, a son of J. J. Bausch, made some experiments towards the manufacture of optical glass, which up to this time and for some time to come, could be obtained only from Europe. His early experiments, however, were not satisfactory.

The year 1915 saw the successful termination of a series of experiments for the manufacture of optical glass. It was of considerable importance to America three years later when the firm was able to offer the Government an excellent quality of optical glass manufactured in its own fully equipped plant. For the war had cut off the foreign supply and Bausch and Lomb manufactured range finders, binoculars, telescopes and many other optical instruments for military purposes. In 1915 Bausch and Lomb optical goods were awarded the prize at the Panama Pacific Exposition.

On the 14th of February, 1926, John Jacob Bausch died at his residence in Rochester. He outlived his partner, Henry Lomb, who died at his home in Pittsford, New York, near Rochester, on June 13, 1908.

The history of this firm is an illustration of the tendency of small events to decide great issues far in the future. Also, it illustrates the fact that occurrences can have far-reaching results of distinctly unrelated nature. Two incidents referred to show this principle at work. One is the loss of two fingers sustained by John Jacob Bausch in 1852 in a wood turning establishment, which led him to decide on optical endeavor as his life work. This Bausch gives as the first turning point in his career. The other is the fact that his attention to small things led him to pick up a piece of hard rubber on the street and from it to get an idea which meant important financial returns to this company in its early period of need. In the incident of the injury, who could foresee the beginning of a series of events leading to the existence of the greatest optical institution in America? And in the finding of the piece of hard rubber, who could have prophesied that the idea it suggested would cancel the debts of the struggling partnership and put a balance in the bank?

Description of a Polarized Light Apparatus for Photo-Elastic Work

*R. V. Baud**

Introduction

IN a previous article a simple optical arrangement for photo-elastic experiments was explained[1]. In this paper a more elaborate apparatus is described.

Description of the Apparatus

Figures 1 to 5 show various designs of photo-elastic arrangements. It is evident that the lenses are merely auxiliary equipment and that the two Nicol prisms, N_1 and N_2 and the two quarter-wave plates, Q_1 and Q_2 comprise the essential part of the system.[2]

When a light ray enters a Nicol prism it is split into two rays. One of these rays is called the "ordinary ray," o. r., the other the "extraordinary ray," e. r.

The ordinary ray follows Snellius' sine law of refraction. The velocity of this ray within the Iceland spar is independent of its direction of propagation and consequently the index of refraction of this crystal for this ray is constant, $n = 1.6585$.[8]

If a ray, u.p.r. (Fig. 6) enters the prism within an angle $\beta = 90 + 19 + 14 = 123°$, the ordinary ray will be totally reflected on arriving at the layer of Canada balsam, which is an isotropic medium with an index of refraction of $n = 1.54$.[8] The ordinary ray is totally reflected in this case since its angle of incidence is larger than its angle of total reflection. The reflected ordinary ray is then damped out by the black mounting of the prism.

In the case where $\beta = 123°$ or more the ordinary ray is refracted at an angle $\gamma = 3°$ or more (Fig. 6). This, since undesirable, is excluded in the design of the optical system.

The extraordinary ray does not follow Snellius' sine law. Its velocity within the crystal, and therefore, also its index of refraction, depends upon the orientation of the direction of propagation with respect to the optical axis of the crystal. The direction of the extraordinary ray, after the ray u.p.r. enters the crystal, can be found by Huyghen's construction of the wave front (See a textbook on optics). In constructing this surface, the other extreme value of the index of refraction for Iceland spar, which holds for the ray propagating perpendicular to the optical axis, $n = 1.4864$,[8] is used. Since it is desired that the extraordinary ray be refracted instead of reflected from the layer of Canada balsam, the angle

*Research Engineer, Westinghouse Electric & Mfg. Co.

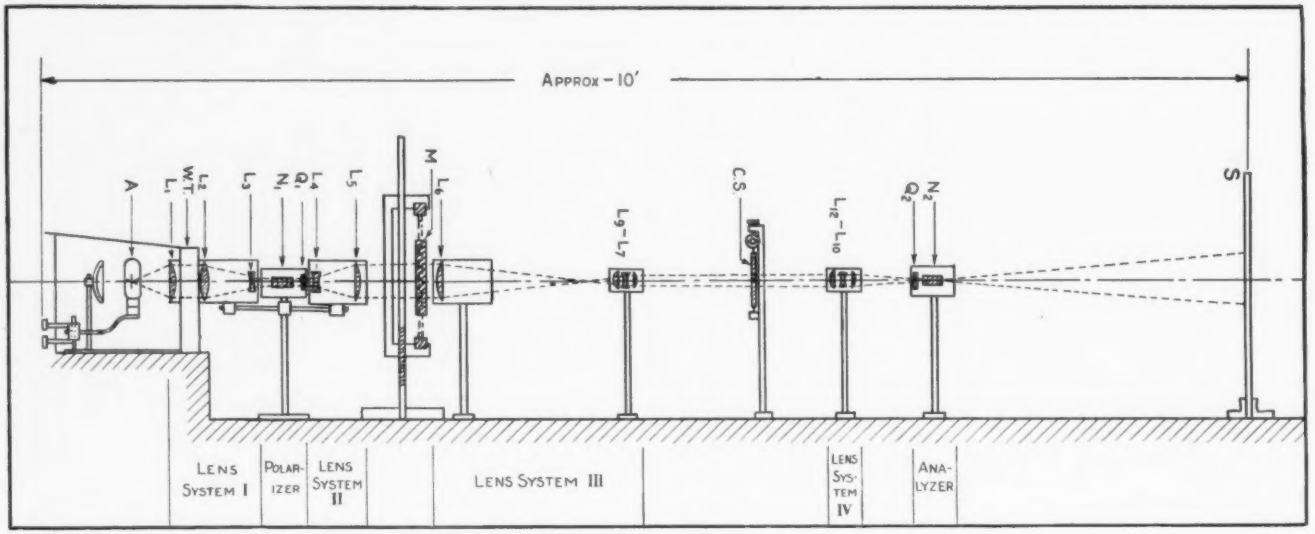


Fig. 1—Coker Apparatus

Light rays from the source, A, are rendered parallel (about 3″ diameter beam) by the Lens L_1 and pass through a tank, W. T. The beam of light is then reduced to one of smaller diameter in order to traverse the first polarizing prism, N_1 [2]. After passing the quarter wave plate Q_1, the beam is broadened again to one which is also parallel and about 3″ in diameter by lens system II. The rays then travel through the model, M, lens systems III and IV, the second quarter wave plate, Q_2, the second polarizing prism, N_2, and the picture of the model, M, is finally projected on the screen, S.

When stress measurements are made, a compensation strip, C. S., machined of the same sheet of celluloid as the model, M, is introduced between the lens systems III and IV in the beam of polarized light of about 1½″ diameter. The various lens systems allow the pictures of the model and of the compensation strip to be properly projected on the screen, either independently, or superimposed for stress measurements.

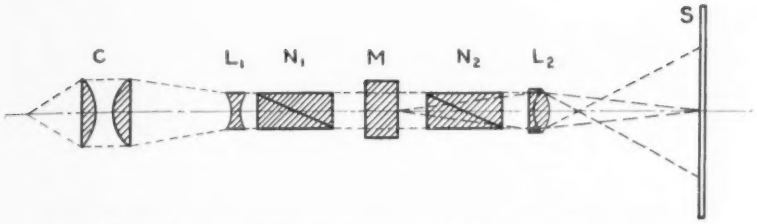


Fig. 2—Simple Apparatus as outlined by O. Hoenigsberg[4] (Austria) and H. Schulz[3] (Germany)

The divergent light rays of the light source are collected by the condenser C and rendered parallel by the lens, L_1. The model, M, is placed between the two crossed Nicols, N_1 and N_2, and its picture is produced by the Lens, L_2 on the screen S, or a plate inserted in the photographic camera.

The width of the beam of polarized light is limited in this apparatus by the size of the Nicol prisms. The supply of large flawless crystals of Iceland spar, however, is very small, so that this arrangement can be used only when a beam of small diameter is required.

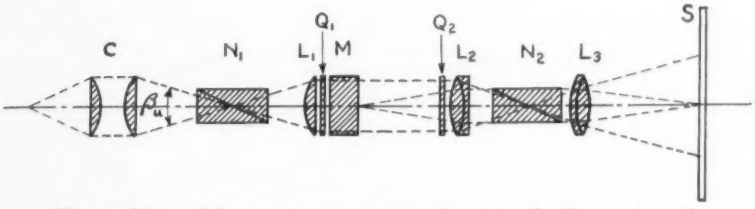


Fig. 3—More elaborate Apparatus as outlined by O. Hoenigsberg[5] and H. Schulz[3]

The system of lenses in Fig. 2 is altered in such a manner that the Nicol prisms are located at those spots where the rays are coned down. This arrangement results in a larger diameter of the beam of polarized light than the one shown in Fig. 2.

The limiting angle, $\beta\mu$, of light incidence upon the Nicol prism is discussed in this paper.

β must be chosen such that the angle of incidence upon the layer of balsam is smaller than the angle of total reflection. Therefore, the angle β cannot be less than a certain critical value, which is $90 + 19 - 10^\circ = 99^\circ$ and $\gamma = 11^\circ$ respectively.

From this it is seen that the useful angle $\beta\mu$ is within the limits 123° and 99°, or $\beta\mu = 24^\circ$. This angle $\beta\mu$ is divided by the middle line MN of the prism into two angles, 10° and 14°. In order that the angle $\beta\mu$ be more equally divided by the line MN the end faces AD and BC are often ground to an angle of 68°.

After the extraordinary ray is refracted into the layer of Canada balsam it passes through it and is refracted into the second half of the Nicol prism. After traveling through this part of the prism the ray is finally refracted again as it leaves the crystal. The angle β upon leaving is equal to the angle β of the ray entering the prism.

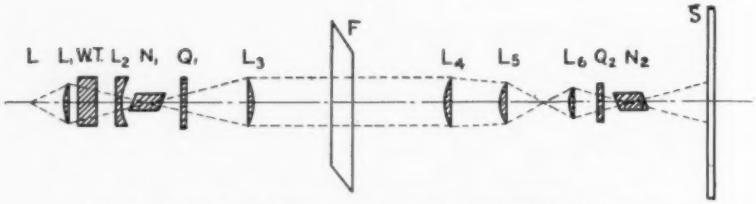


Fig. 4—Diagram of Apparatus as used by the Navy Department
(Dr. E. O. Hulburt—H. B. Maris[6])

Light from source, L, passes through the short focus lens L_1, cooler, W.T., and diverging lens L_2 to the Nicol prism N_1. The light then passes through the quarter wave plate Q_1 and is rendered parallel by lens, L_3. The test piece is in frame F. the light is then converged by lens, L_4, and a short focus lens, L_5, and passes through lens, L_6, quarter wave plate, Q_2, and Nicol prism, N_2. The picture appears on screen, S. A compensation strip is placed between lenses L_5 and L_6 although the beam is not parallel between these lenses. It should, in the writer's opinion, be in place where the rays travel perpendicularly through it as in Figures 1 and 5.

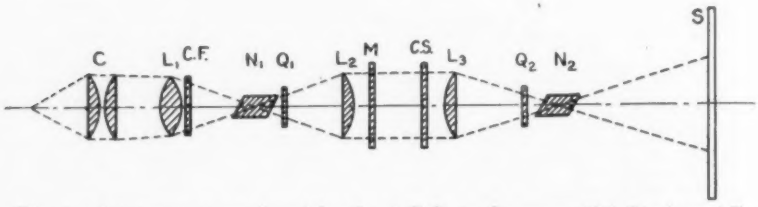


Fig. 5—Apparatus as employed by the A.E.G. in Germany (W. Birnbaum)[7]

This apparatus consists of a condenser C, a lens L_1 with color filter, C.F., crossed Nicols, N_1 and N_2, crossed quarter wave plates, Q_1 and Q_2, and two large lenses, L_2 and L_3 of 100 mm diameter. Both the model, M, as well as the compensation strip, C.S., are placed between the lenses L_2 and L_3.

When a light ray Z_A (Fig. 7) enters a mica plate, such as is used for a quarter-wave plate in the apparatus described above, we may assume, for simplification, that the ray is split into two rays Z_M and Z_N both of which travel perpendicularly through the plate.

So far, the light propagation through the polarizing apparatus was discussed from the view-point of geometric optics. In further discussions the wave propagation of the light through Nicol prism and mica plate will be studied.

Looking in the direction of light we will assume that there is a vibration transverse to the direction of propagation. If this transverse vibration is oriented at random, the light ray is unpolarized. If, on the other hand, the angular position of the plane of vibration is stationary, the light is called plane polarized. According to Fresnel's assumption, the vibration of a plane polarized light ray takes place in a plane perpendicular to its plane of polarization.

Assume that an unpolarized ray, u.p.r., enters a Nicol prism; then it is split into two plane polarized rays. The plane of polarization of the

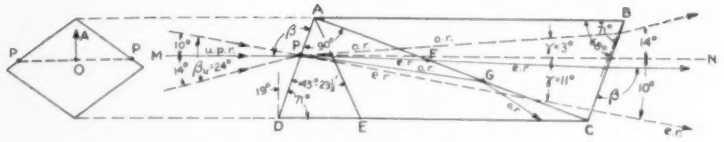
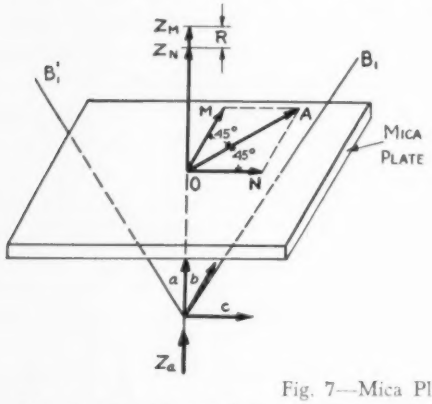


Fig. 6—Nicol prism

Iceland Spar is a uniaxial (negative) crystal. It has 6 obtuse edges, where two planes are inclined 105°05′ and 6 acute edges, where two planes are inclined 74°55′ to each other. The optical axis is the line going through the obtuse corner A, inclined 45° 23½′ to the planes, which pass through point A.



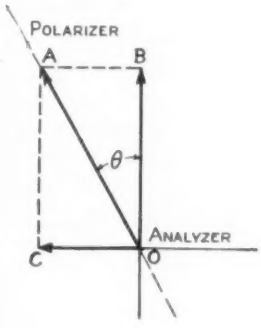


Fig. 7—Mica Plate

Mica is a biaxial crystal; B_1 and B_1' are the two optical axes; a, b, and c, are the optical symmetry axes.

Fig. 8—Polarizer and Analyzer inclined 90 — Θ °.

extraordinary ray is shown as the plane P-P-F in Figure 6, and, therefore, according to the definition above, the vibration of the extraordinary ray occurs in a vertical plane. This ray is represented by the light vector OA in Fig. 6. The vibration of the ordinary ray takes place in the plane P-P-G. We have seen that the ordinary ray does not appear in the final beam.

In the photo-elastic apparatus two Nicol prisms are arranged in series, the second being rotated 90° with respect to the first. The first prism is usually placed so as to emit extraordinary rays of vertical vibration; the second, due to the 90° rotation, will emit extraordinary rays vibrating in a horizontal plane. Such an arrangement is called "crossed Nicols" and forms the basis of the more elaborate photo-elastic apparatus. The first prism is termed the polarizer, and the second the analyzer.

If nothing but unstrained lenses are inserted between the crossed Nicols, no light from the lamp reaches the screen. This is because the extraordinary ray of the polarizer becomes the ordinary ray in the analyzer and is absorbed by the black-painted mounting of the analyzer. If the angle between polarizer and analyzer were 90° — Θ (see Fig. 8), then the polarized ray represented by vector OA, would be split by the

analyzer, as shown in Figure 8, and only the extraordinary ray represented by the component light vector OC would be allowed to pass.

The arrangement of the two crossed Nicol prisms corresponds to the simple optical arrangement of two black glass plates for polarizer and analyzer, which was described in an earlier paper[1]. The explanation connected with Figures 3, 4, 5, and 6, given in this previous paper also holds in our present case.

Since the Nicol prisms are usually arranged in rotatable mountings reading to one degree, the *prisms* can be rotated to find the *directions of the stresses,* whereas in the simple apparatus previously discussed it was necessary to rotate the loaded model. Furthermore, it was pointed out in the earlier paper that dark spots appearing on the screen in photoelastic work are either due to the fact that $\alpha = 0$ (where α is the angle between one of the two principal stresses and the plane of polarization) or that $p = q$. As confusion is likely to occur as to the cause of the dark spots, the first cause is usually eliminated, provided the magnitude of $(p-q)$ is being measured or a picture of the shear stress distribution is desired. This elimination is accomplished by placing a mica plate after the polarizer. The mica affects the plane polarized ray Z_A (Figure 7) produced by the first Nicol prism in the following manner. It is split into two plane polarized rays Z_M and Z_N, represented in Figure 7 by the light vectors OM and ON. In the instrument these light vectors are made equal by taking the plane of polarization of Z_A at such a position that the angles between it and the plane of polarization of Z_M and Z_N are each 45°. These two rays Z_M and Z_N pass through the celluloid model; consequently, whatever the angle α may be, there are always extraordinary rays traversing the analyzer. Hence, the possibility of a black spot caused by a coincidence of the plane of polarization with the plane of one of the principal stress directions is excluded.

However, the retardation introduced by the first mica plate is added to the retardation produced by the celluloid model, which is undesired. The remedy consists in placing a second mica plate before the analyzer with its axes turned 90° with respect to the first plate. This causes the velocities of the rays in the mica to be interchanged; consequently, the retardation produced by the second mica plate nullifies that introduced by the first. The final retardation is, therefore, *only* that produced by the stress difference $(p-q)$ in the celluloid.

It is obviously necessary that the two mica plates, if made from the same material, are of the same thickness. The thickness (in mm), required to produce a certain retardation R (in wave lengths) can be calculated from the equation:

$$R = \frac{t}{\lambda}(n\gamma - n\beta)$$

where λ is the wave length of the light (in mm) for which the retarda-

tion R is desired, and $n\beta$ and $n\gamma$ are indices of refraction for the rays vibrating in the directions b and c (Figure 7).

For "Muscovite Mica" $KH_2 Al_3 (SiO_4)_3$, which has the indices of refraction $n\beta = 1.5967$ and $n\gamma = 1.6005$ * provided Thallium light (yellow-green, λ=5350 A°ngstroms) is employed, a quarter wave retardation (R = 0.25) is obtained for a thickness of the mica plate of 0.035 mm. The retardation will then be somewhat less for red rays, and somewhat larger for violet rays. It may be assumed, however, that the second mica plate nullifies the retardation of the first, whether this retardation is exactly a quarter-wave or not. It may be necessary, however, to use monochromatic light for very accurate work.

A photo-elastic apparatus of Prof. E. G. Coker's design, Fig. 1, was purchased by the Westinghouse Electric & Manufacturing Co. about five years ago. It included a loading apparatus for the compensation strip. This loading apparatus is composed of a system of levers and a special spring balance. It is now being replaced by one employing a dial gage and ring spring arrangement of our own design. The tank and the arrangement for supporting and loading the model, see Fig. 9, have been added here. The latter consists of two movable frames: one, ABCD, which may be raised or lowered by a screw and worm-gear arrangement, driven by a small motor; and the other, EFGH, which slides horizontally in the first. By using this flexible arrangement, any point of a large model can be placed in the field of polarized light, and its stresses on the screen can be viewed without varying the set-up. The load is applied

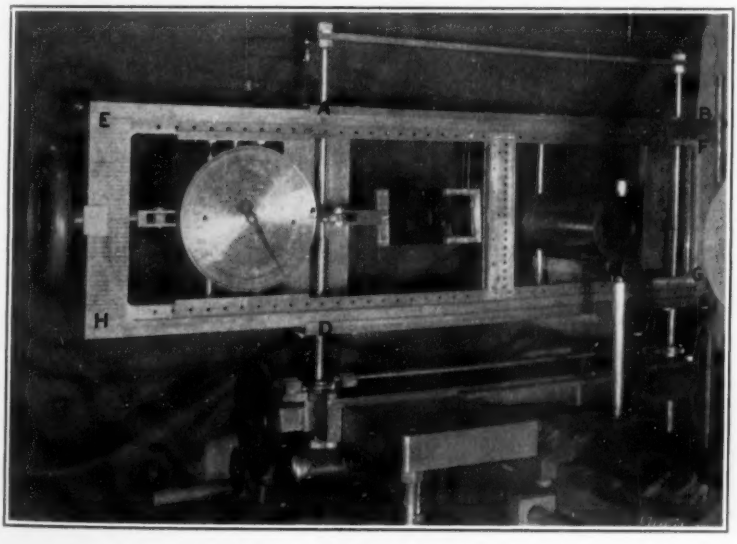


Fig. 9

to the model by means of a screw arrangement and is read on a spring scale.

The tank consists of two parallel glass plates mounted in opposite walls of a metal container. This tank is filled with some liquid (alum, distilled water, etc.) which will not appreciably affect visible rays, but will absorb those rays which, for the materials involved, produce heat. This cooling system is necessary to absorb the intense heat which otherwise would be produced because of the fact that the light beam is coned down to one small enough to enter the polarizer.

As a light source a 30 volt, 30 ampere motion picture lamp, equipped with a 12 mm² filament, manufactured by the Westinghouse Lamp Co., Bloomfield, is used. In order to facilitate operation of the photo-elastic apparatus, the electrical control of the equipment, room lights, motors, etc., is conveniently centralized near the screen.

The crossed-Nicol arrangement[2] was obtained in our apparatus experimentally by placing a photo-electric cell in place of the screen, and varying the angular settings of one of the prisms until a reading of a sensitive galvanometer, connected in the electric circuit with the cell, indicated that the amount of light striking the cell was a minimum. Then two quarter-wave plates were inserted in the optical set-up and rotated until the galvanometer again indicated a minimum of light. After this the plates were each rotated through an angle of 45°, but in opposite directions. After that the cell was replaced by the screen. The positions of the quarter-wave plates were noted, and then removed. A tensile test piece was inserted in the field of the polarized light and stressed in a vertical direction. The prisms were again rotated, the 90° angular relation between them being maintained, until the strip appeared black on the screen. When this condition was satisfied, extraordinary rays of vertical (or horizontal) vibration were emitted from the polarizer; and, after the quarter-wave plates had been reinserted in their proper places, the final set-up was obtained.

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1) R. V. Baud, A Simple Optical Arrangement for Photo-Elastic Experiments, Instruments, Vol. No. 1, No. 7. July 1928, p. 305.

2) In this paper it is assumed for simplification that Nicol prisms are employed in the instruments shown in Figs. 1-5. In reality these prisms are not necessarily of the "Nicol" type. There exist various designs of polarizing prisms involving the same principles. In the Coker instrument for instance, a thin slice of Iceland spar is cemented to a pair of glass wedges.

3) Der Betrieb, 1921, No. 14, p. 408.

4) Zeitschrift des Oesterr.—Ing. und Architekten Vereins, 1904, No. 11.

5) Zeitschrift des Oesterr.—Ing. und Architekten Vereins, 1905, No. 42.

6) Journal of the Optical Society of America and Review of Scientific Instruments, Vol. 15, No. 4, p. 210.

7) Zeitschrift für Technische Physik—Vol. 5 (1924) No. 4, p. 143.

8) The indices of refraction given are for D-light, (Sodium, $\lambda = 5890$ A°ngstroms).

Transverse Tests on Round and Square Bars of Grey Cast Iron***

*A. L. Norbury, D.Sc.***

IT is well-known that square transverse test bars of cast iron give a lower modulus of rupture value than round bars of approximately the same cross-section. This difference has usually been attributed to a casting effect such as chill or strain in the corners of square bars, consequent on more rapid cooling.

The following tests show, however, that a large part of the difference is due to the fact that the modulus of rupture formulæ generally used do not hold in the case of cast iron when applied to compare transverse test results on round bars with those on square bars.

The present tests consisted in casting* six square bars 1½-in. by 1½-in. by 16-in., and machining three of them to give round bars, large, medium, and small, and three to give square bars, large, medium and small. Six 1½-in. diameter round bars, each 16-in. long, were also cast and three machined to give square bars, large, medium, and small, and three to give round bars, large, medium, and small. The sections as cast and as machined are shown in the figure on the following page.

The twelve machined bars were then broken in transverse on 12-in. centres, and the results calculated as moduli of rupture according to the usual formulæ given below. The resulting moduli of rupture worked out at between 24.6 and 26.6 tons per square inch for the machined square bars and between 27.5 and 29.4 tons per square inch for the machined round bars. The results are in the accompanying figure.

Among the machined square test bars there was no systematic difference between the strengths of those machined from the cast square bars and those machined from the cast round bars. Similarly, among the machined round test bars the strengths were the same irrespective of whether they had been machined from cast square or cast round bars. The average strength of the machined square test bars works out at 25.5 tons per square inch, the average of the machined round bars at 28.6 tons per square inch, the maximum differences from the average figures being 1.1 tons per square inch (about 4 per cent) in each case. In other words, the results on the machined square bars are 11 per cent lower than those on the machined round bars. This difference is obviously not due to any casting effect in the present tests, and consequently must be

*The six square and six round bars were all cast vertically in green sand from the same runner and from the same ladle of cupola metal. The analysis was: T.C. 3.26 per cent, C.C. 0.76 per cent, Si. 1.32 per cent, Mn. 0.53 per cent, S. 0.105 per cent, P. 0.98 per cent.

**Senior Metallurgist, British Cast Iron Research Association.

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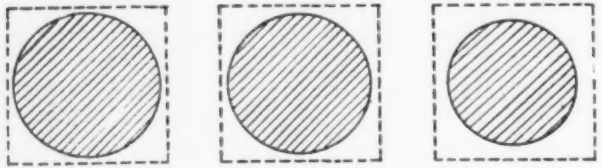
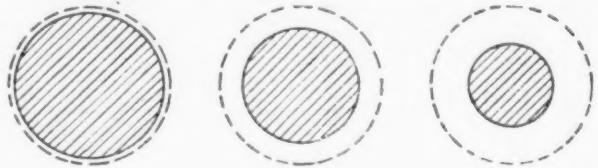
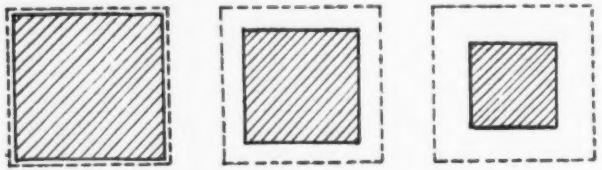
TRANSVERSE STRENGTHS OF ROUND AND SQUARE BARS MACHINED FROM BARS CAST ROUND AND SQUARE.



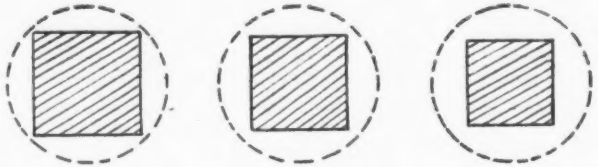
	Cast size	
1.5-in. sq	1.5-in. sq	1.5-in. sq
	Machined size	
1.4-in. dia.	1.3-in. dia.	1.2-in. dia.
Modulus of Rupture (tons per sq in.)		
27.8	29.3	28.7
	AVERAGE, 28.6	



	Cast size	
1.5-in. dia.	1.5-in. dia.	1.5-in. dia.
	Machined size	
1.4-in. dia.	1.1-in dia.	0.8-in. dia.
Modulus of Rupture (tons per sq in.)		
27.5	29.4	29.2
	AVERAGE, 28 7	



	Cast size	
1.5-in. sq	1.5-in. sq.	1.5-in. sq.
	Machined size	
1.4-in. sq.	1.1-in. sq.	0.8-in. sq
Modulus of Rupture (tons per sq. in.)		
26.6	24.9	24.6
	AVERAGE, 25.4	



	Cast size	
1.5-in. dia.	1.5-in. dia.	1.5-in. dia
	Machined size	
1 0-in. sq.	0.9-in. sq.	0.8-in. sq
Modulus of Rupture (tons per sq. in.)		
25.9	25.2	25.5
	AVERAGE, 25.5	

due to the fact that the formulæ employed are not strictly applicable for comparing the transverse strengths of round bars with those of square bars in the case of cast iron.

If the present results are examined in detail, it will be seen that the formulæ employed are applicable within the limits of experimental error (about 4 per cent) as a means of comparing the transverse strengths of large (1½-in. by 1½-in.) square bars with small (0.8-in. by 0.8-in.) square bars, or of large (1.4-in. diameter) round bars with small (0.8-in diameter) round bars, assuming that the cast bars do not vary appreciably in strength from edge to centre, which is apparently the case in the present tests.

Adamson and Bell (*J.I.S.I.*, 1924, No. 1, p. 347) and (*Carnegie Scholarship Memoirs*, Vol. 16, 1927, p. 1) carried out transverse tests on a number of large and small round and square bars of cast iron, tested them as cast, and obtained lower modulus of rupture results on square bars than on round bars. They attributed these differences to the formulæ being inapplicable, but it is not clear that they do not attribute differences between small and large round bars and between small and large square bars to the same cause (inapplicability of formulæ) without sufficiently considering the difference due to the well-known effects of different rates of cooling on the strength of cast iron.

Tensile tests on two of the bars used in the present tests machined to 0.798-in. diameter gave ultimate strengths of 13.4 and 14.0 tons per square inch.

TRANSVERSE FORMULAE

$$\text{Modulus of rupture in tons per sq. in.} = \frac{W.l.}{4} \times \frac{d^3}{32} \text{ for round bars.}$$

$$\text{Modulus of rupture in tons per sq. in.} = \frac{W.l.}{4} \times \frac{32a^3}{6} \text{ for square bars.}$$

Where W = breaking load in tons
l = length between supports
d = diameter of bar
a = length of side of bar.

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P. H. Schweitzer, Associate Professor of Engineering Research at the Pennsylvania State College, is going abroad at the end of this month to take his Doctor's degree at a German university. Before returning he will meet and confer with the leading builders of Diesel engines in Europe.

Professor Schweitzer is in charge of the Diesel oil spray research at Penn State. During his absence K. J. De Juhasz, the well-known inventor of a high speed indicator, will substitute for him in conducting the investigation.

Instruments Collaborators

Prof. F. C. Ashe, Head of Electrical Equipment and Construction Department, Carnegie Institute of Technology, Pittsburgh, Pa.

Dr. James Aston, Head, Department of Mining and Metallurgy, Carnegie Institute of Technology, Pittsburgh, Pa., and Consulting Metallurgist, A. M. Byers Company.

R. V. Baud, Research Engineer, Research Laboratory, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Dr. G. Berndt, Professor an der Technischen Hochschule, Dresden, Germany.

Dr. F. L. Bishop, Professor of Physics, University of Pittsburgh, Pittsburgh, Pa.

Prof. Wm. G. Brown, Asst. Professor of Aeronautics, Massachusetts Institute of Technology, Cambridge, Mass.

Prof. K. J. de Juhasz, Experimental Engineering Department, Pennsylvania State College, State College, Pa.

R. L. Dunlap, Power Department, Bell Telephone Company of Penna., Pittsburgh, Pa.

Owen W. Ellis, Research Engineer, Research Bureau, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Dr. Waldemar Ewald, Physicist, Askania-Werke, A. G., Berlin-Friedenau, Germany.

Paul B. Findley, Editor, Bell Laboratories Record, Bell Telephone Laboratories, New York, N. Y.

A. A. Grubb, Director of Laboratories, Ohio Brass Company, Mansfield, Ohio.

Prof. J. B. Grumbein, Professor of Steam and Experimental Engineering, University of West Virginia, Morgantown, W. Va.

Robert G. Guthrie, Consulting Metallurgist, Peoples Gas Light and Coke Company, Chicago, Ill.

Prof. Lester Hamilton, Associate Professor of Analytical Chemistry, Massachusetts Institute of Technology, Cambridge, Mass.

Dr. John L. Haughton, Senior Assistant, National Physical Laboratory, Teddington, Middlesex, England.

H. L. Hazeltine, Chief Engineer, Sterling Varnish Company, Pittsburgh, Pa.

John L. Hodgson, Technical Expert, George Kent, Ltd., Eggington, England.

Prof. George Hosmer, Professor of Geodesy, Massachusetts Institute of Technology, Cambridge, Mass.

Prof. J. W. Howard, Associate Professor of Topographical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Prof. Hans von Jueptner, University of Vienna, Vienna, Austria.

Dr. Friedrich Koerber, Director of the Kaiser-Wilhelm-Institut fuer Eisenforschung, Dusseldorf, Germany.

Dr. V. M. Krivibok, Asst. Director, Metallurgical Research Bureau, Carnegie Institute of Technology, Pittsburgh, Pa.

A. A. Lebedeff, Physicist of the Optical Institute, Leningrad, Russia.

John M. Lessells, Engineer in Charge, Mechanics Section, Research Laboratory, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

E. S. Lincoln, Consulting Electrical Engineer, New York, N. Y.

Richard R. Moore, Engineering Department, Wright Aeronautical Corporation, Paterson, N. J.

Dr. Allen Leslie Norbury, Senior Metallurgist, British Cast Iron Research Association, Birmingham, England.

Prof. P. H. Schweitzer, Associate Professor of Engineering Research, Pennsylvania State College, State College, Pa.

Dr. Harry Seltz, Asst. Professor of Chemical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

Dr. Foster D. Snell, Consulting Chemist, Honorary Secretary of the American Section of Society of Chemical Industry, New York, N. Y.

Thomas Spooner, Asst. Director, Research Laboratory, Westinghouse Electrical and Manufacturing Company, East Pittsburgh, Pa.

Francis M. Turner, Jr., Vice-President and Editor, Chemical Catalog Company, New York, N. Y.

Prof. J. W. Tynan, S. J., Assistant Head of the Physics Department and Director of the Seismic Station at Fordham University, New York, N. Y.

Dr. S. R. Williams, Professor of Physics, Fayerweather Laboratory of Physics, Amherst College, Amherst, Mass.

Prof. W. R. Work, Head of the Department of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

C. B. Wright, Supt. Power Distribution, Duquesne Light Company, Pittsburgh, Pa.

A New Engine Indicator

Max Hartenheim, Pittsburgh, Pa.

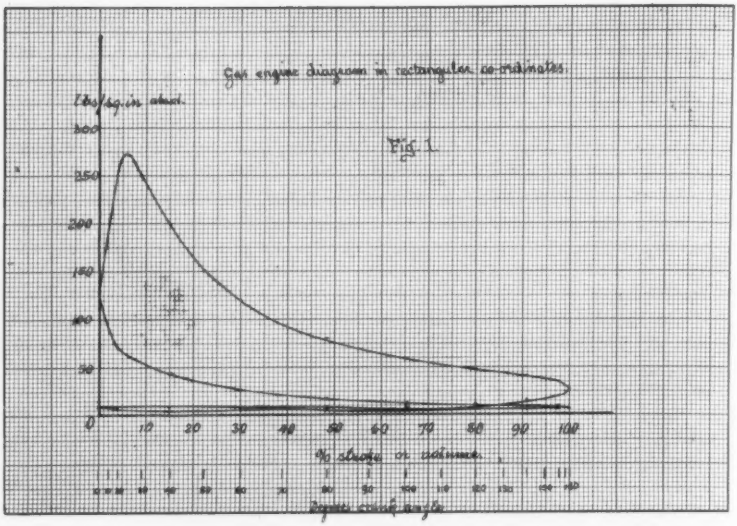
IT is usual to record the pressure diagram of a steam or gas engine in the rectangular coordinate system, whereby the pressure within the cylinder is given as the function of the stroke of the engine or of the volume of the cylinder. Although another coordinate system, that of polar coordinates, is known, its use has been mainly reserved for photometry or for plotting electrical or mechanical occurrences of a mostly rotating nature as a function of angular deviations. So far it has never been tried, to the knowledge of the writer, to directly record mechanical phenomena in polar coordinates in spite of distinct advantages which the polar pressure diagram of an engine would have over the rectangular diagram, advantages which lie in mechanical as well as in practical direction.

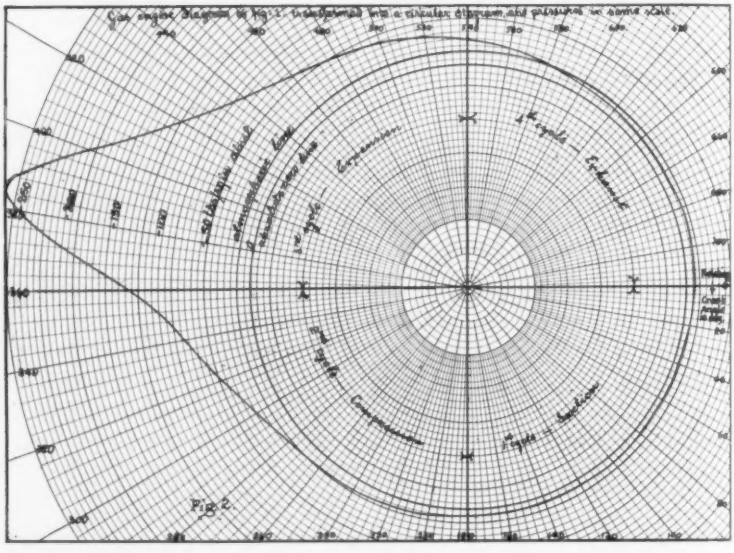
In the following a new method of indicating diagrams will be described in which, however, the polar diagram is modified for mechanical reasons; instead of having a point as the zero for the diagram, a circle is used as the zero line and the positive and negative values of pressure are the lengths of the radii vectors outside and inside the zero circle respectively. This system can be considered as a circular coordinate system; it has been used for the recording of electrical phenomena (see *Electric Journal*, February and May, 1914). It has also been used for plotting pressure diagrams of high speed explosion engines as is described in a bulletin of the Bureau of Standards of a new high speed indicator (Report 107, 1921).

This new method has the following advantages:

I. *Mechanically*. When taking a diagram with the usual indicator, great care must be taken, particularly for high speeds that the mass of the paper drum is as light as possible, because of the reciprocating motion which is given to it by the corresponding motion of the piston rod or crosshead to which it is generally connected. For the new method the paper holder is not a drum but a disk, rotating continuously in the same direction, before the pencil of the indicator and its mass is therefore of no import; on the contrary, a greater mass would contribute to greater uniformity of motion. Furthermore, it is not necessary to place the cords which transmit the movement of the engine to the paper holder as accurately in the new method as in the old, since only a rotary motion is to be maintained and not one absolutely proportionate to the piston rod. This results in a simplification of the guide rolls.

II. *Practically*. The advantages in this respect will easily be seen from a comparison of the diagrams Fig. 1 and Fig. 2 and are particularly conspicuous in the case of four stroke cycle engines, i.e., gas engines. As seen in Fig. 1 the abscissa representing the stroke is used twice for a





steam engine and four times for a gas engine. In a circular diagram, however, the abscissæ axis for the strokes forms one continuous line, a circle, which obviously tends to make the diagram much larger than can be obtained in rectangular coordinates. Furthermore, as the speed for one revolution is uniform while the movement of the drum and piston rod follows a sine law, the diagram becomes clearer just at the beginning and end of the stroke, where admission, ignition and exhaust occur; in rectangular coordinates this is just where the movement of the drum is

almost zero so that the important movements of the valves are recorded on a very small length of the abscissæ axis. The greater lengths of this period in the new diagram permit, therefore, a more accurate analysis of the operation of valves, ignition, etc., and secondly the greater benefit of a more exact evaluation of the diagram.

The paper disk which rotates before the pencil can have a diameter as large as is convenient with practical conditions. The practical arrangement can be made most advantageously in such a way that the pivot center of the paper holder is fixed to the bottom of the indicator. Moreover the movement of the indicator piston can be utilized directly without the intermediary of the link mechanism as is necessary for the drum indicator. It is obvious that the basis of the diagram—the atmospheric circle—has a much greater length than in the usual diagram on the drum. As the length of the circle is to represent one full cycle, i.e., two strokes or four strokes respectively, the disk must be geared to the shaft in the ratio of 1:2 or 1:4.

This arrangement would give the diagram of just one cycle, or when more diagrams are taken, they would superpose each other. In order to be able to take continuous diagrams as is possible with the drum in an ordinary indicator, an arrangement must be made which, after each cycle, shifts the starting point for the next cycle a little. This can be done in two ways:

I. A ratchet slips a certain amount after each revolution of the paper disk a few degrees.

II. Arranging the gearing so that it is not exactly 1:2 or 1:4, but somewhat more or less so that one complete cycle is a little less or more than one revolution of the disk. In this way each new cycle starts a little behind the foregoing cycle, and a continuous open diagram is obtained of the kind recorded on the paper drum when the latter is arranged for taking a continuous diagram. The error due to this small slip is negligible.

The two diagrams Fig. 1 and Fig. 2 represent the same high speed gas engine, Fig. 1 plotted in rectangular, Fig. 2 in circular coordinates, both with the same pressure scale.

The greater clearness especially in exhaust and suction period is evident. The diagram can be evaluated in the same manner as the rectangular diagram.

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REQUESTS are received daily for back issues of INSTRUMENTS and we are sorry that it is not possible for us to comply with these requests.

In answer to our appeals for the return of copies of this issue we have to-date received so few copies that there are still over three hundred requests we cannot fill.

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Research of Instrument Literature.

Instruments and Methods of Determining Flash Point.

Dilatometry.

Temperature Control in Process Industries.

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The Measurement of High Temperature by Radiation Pyrometers.

Thermometry.

Modern Precision Measuring Tools for Machine Shop Use.

Why Flyers Need Instruments.

Organization in Research.

Weighing Devices.

Conservation through Metering.

The Measurement of Illumination.

Flow Measurement.

Blind Flying Instruments.

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Fluid Meters.

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The Measurement of Pressure.

Speed Recording Instruments

New Inventions Needed.

Instruments applied to the Open Hearth for Efficiency.

Thermoradiometers.

Mechanical Vibrations and Their Measurement.

Instruments to improve Diesel Engine Efficiency.

Comparison of Instruments for Measuring Hardness.

The Calculagraph*

By H. C. Dilsizian

THE Calculagraph as designed for telephone service was developed to provide an accurate means of computing the duration of long distance conversations. Its true value to the telephone world can be appreciated best by a brief survey of its predecessors.

Before the advent of the Calculagraph, it was the practice in many exchanges to record the start and finish of toll calls by glancing at a wall clock and writing down the time in longhand on tickets provided for the purpose. These tickets were taken to clerks who computed the elapsed time by subtracting one record from the other. A check for accuracy of computation was made by a second group of clerks. Careful tests showed that, because of the human element involved in this practice, approximately 20 percent of the records contained inaccuracies of one minute or more. In practically every instance these errors were in favor of the subscriber.

The use of time stamps for recording the start and finish of conversations was a decided step forward. While the human element was thereby partially eliminated the actual computation of elapsed time was performed by clerks and the precautions taken could not prevent errors.

Another instrument used was the stop watch, which indicated the exact duration of a call by pressing a button at the start and finish of a conversation. The stop watch, however, presented several serious disadvantages. With it the operator could handle only one call at a time and the actual record had to be made in longhand, which involved loss of time for the operator, and impaired the general efficiency of the service.

The problem, therefore, was to overcome the weak points of these methods and devise a machine which would embody their respective advantages. It was required in effect that the desirable features of time stamps, namely, the accurate recording of the start and finish of a conversation, be combined with the accuracy of the stop watch in indicating elapsed time; that provision be made for recording this elapsed time; and, finally, that the machine desired should be capable of handling, practically simultaneously, not only one, but an unlimited number of calls. The solution to the problem was the Calculagraph.

The Calculagraph (Figure 1) is either a spring driven or an electrically actuated time recorder, which prints the date and time of the day similar to other time stamps, but it also has the exclusive feature of automatically computing and printing the length of time elapsed between the start and finish of an operation. Its special construction enables it to record accurately the duration of an unlimited number of toll calls without re-

*Abridged by permission from "Electrical Communication."

gard to the consecutive order of starting. In practice a Calculagraph usually is placed between two operators who employ it on all toll calls handled by them for recording the start and the finish of conversations.

At the commencement of a conversation the operator inserts a ticket in the slot of the Calculagraph and moves the right hand lever backward and then forward. The backward movement prints the hour of the day in the form of a clock dial, and immediately below, if desired, the year, month and day. The triangular pointer shown just above "X" in Figure 2 corresponds to the hour hand of the clock; the arrow within the circle,

Fig. 1—The Calculagraph.

to the minute hand. Thus the record reproduced in the figure indicates that the call was connected on May 5, 1927, at 10:10 A. M. Incidentally, it may be of interest to note that it is necessary to set the date stamp each day; the A.M. and P.M. designations are controlled automatically by the Calculagraph mechanism.

The forward motion of the right hand lever prints the two elapsed time dials, together with the serial number of the machine. After this operation the ticket is withdrawn from the slot, the record at this stage appearing as in Figure 2 and the Calculagraph is ready for stamping tickets for other messages in a similar manner.

When a call is completed, the ticket covering it is again inserted in the slot of the Calculagraph and the left hand lever is pulled forward. This operation stamps the pointers in the two elapsed time dials imprinted at the start of the call, thereby indicating the elapsed time in

minutes and fractions. The completed record appears as illustrated in Figure 3, which shows that the call lasted four minutes.

To insure the record being started and completed on the same instrument, one of the elapsed time pointers bears the serial number of the machine corresponding to that stamped by the forward motion of the right hand lever at the beginning of the call.

The Calculagraph, in addition to being silent in operation, is of the highest quality, entirely hand assembled, and is given a series of rigid

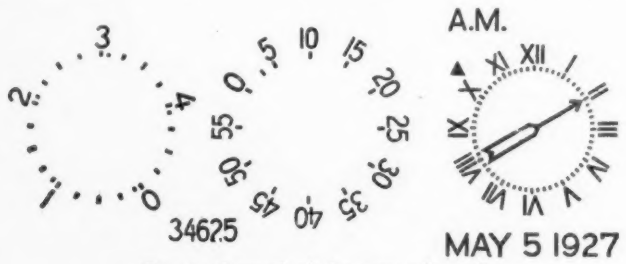

Fig. 2—Record of the start of a call.

inspections during the course of manufacture. Contrary to what might be expected, the mechanism is extremely simple and rugged. Each of the two printing dials which record the elapsed time is made of two parts, one part carrying the circle of figures and division marks and the other, the pointer or arrow. The two parts are secured together rotatively by a dowel pin, whereby the arrow always points to the zero mark of the circle. The vertical movement of the parts is independent of each other.

It was mentioned previously that the forward motion of the right hand

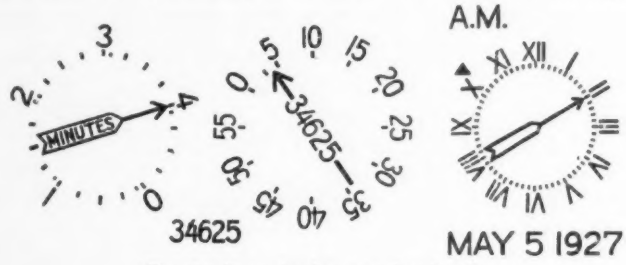

Fig. 3—Record of a completed call.

lever stamps the two elapsed time dials. That operation forces the figures upward and causes them to make an impression on the record, while the arrows, which always point to the zero mark in the circle, remain depressed. When the left hand lever is operated at the end of the conversation, the arrows alone move up, while the figures remain in their original position as indicated in Figure 4.

During the interval between the beginning and the end of a call, the dials containing the circle of Arabic numbers and their associated point-

ers revolve in unison; and the record card always is inserted into the Calculagraph in the same position. Since the circles are stamped at the beginning of the call and the pointers at the end, the positions of the arrows within the circles indicate the elapsed time or duration of the call. By means of the smaller of the two elapsed time dials the duration of the call may be read accurately without difficulty.

Irrespective of the position of the zero mark when imprinting the larger elapsed time dial at the start of a conversation, it will have travelled 60° at the end of a 10-minute call. If the arrow which travels along with the zero mark is stamped at the conclusion of the call, it will point to "10" on the imprint. In the meantime, if a second call is started im-

Fig. 4—Illustration of movement of arrows when recording the end of a conversation.

mediately after recording the beginning of the previous call and, for example, continues for 6¼ minutes, the zero mark and its associated arrow in the larger circle will have travelled 37½° from the point of origin of the second conversation. The impress of the arrow (Figure 3) made at the conclusion of the call will point a little to the right of "5." At this time the arrow in the smaller dial will have described an arc of 450°, or one complete revolution plus 90°, and will point to 1¼. The "5" of the larger dial plus the 1¼ of the smaller will indicate the exact duration of the call.

It will be noted that the recording of the second call has no bearing whatever on the first. With the Calculagraph any number of calls may be handled and be recorded accurately without regard to sequence.

New Instruments

Recently Developed by Instrument Manufacturers

The Parkspray Psychrostat

(Parks-Cramer Company)

THE Parkspray Psychrostat is a rugged, reliable Psychrometric Humidity Controller for use at temperatures between 60° F. and 110° F. Unlike most instruments for this purpose it has neither hygroscopic element or moistened wick.

Fig. 1

The instrument is a form of differential thermostat controlling any desired pre-determined atmospheric condition of the air regardless of changes in dry bulb temperature. Such a relation might be any one of the following: constant absolute humidity, constant relative humidity, or constant moisture content of material being processed.

The most unique feature of the instrument is the method of obtaining the wet bulb temperature (see Fig. 2). This eliminates the moistened wick which is a source of error and usually involves the human element in keeping it in proper condition and moist.

The instrument is designed for pneumatic operation (30 lb. air pressure) and through integral relay valves actuates diaphragm valves,

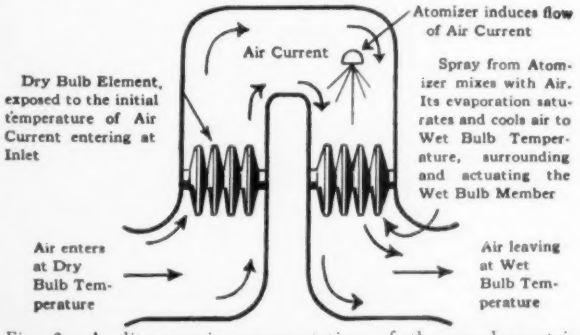
Atomizer induces flow of Air Current
Air Current
Dry Bulb Element, exposed to the initial temperature of Air Current entering at Inlet
Spray from Atomizer mixes with Air. Its evaporation saturates and cools air to Wet Bulb Temperature, surrounding and actuating the Wet Bulb Member
Air enters at Dry Bulb Temperature
Air leaving at Wet Bulb Temperature

Fig. 2—A diagramatic representation of the psychrometric principle as applies to the Parkspray Psychrostat.

damper lever motors, pneumatic switches, or other devices in connection with air conditioning apparatus.

Control of dry bulb temperature or wet bulb temperature independently of the relation between them can also be incorporated without sacrificing the original purpose of the instrument.

A removable key serves to adjust the instrument to any desired humidity condition between 25 per cent and saturation.

The Parkspray Psychrostat is ordinarily used for controlling any one of the complete line of humidifying devices built by the manufacturer, but has been furnished for control of many special applications in various industries.

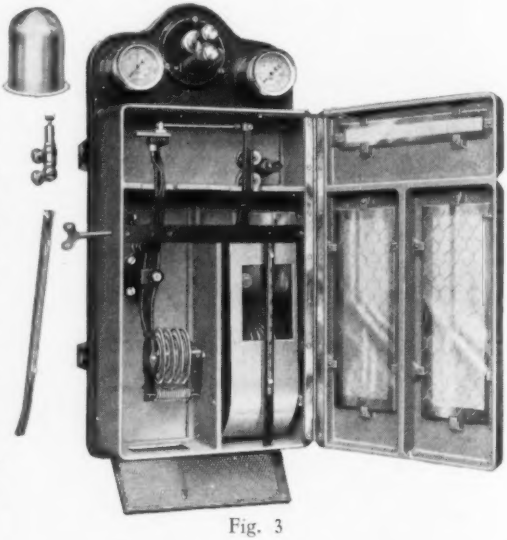

Fig. 3

In industrial instruments, accessibility and means for ease in care and maintenance are very important. This photograph shows the Psychrostat as much dissembled as a mill employe will ever find necessary. Not all of these points need attention at the same time. The Psychrostat needs only occasional and not highly technical care.

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METER MANUFACTURERS ORGANIZE INSTITUTE FOR CO-OPERATION

At a meeting held at the Engineers Club, New York City, the American Water Meter Institute was organized, officers were elected, committees appointed and the ground work established for bringing about a better understanding of the meter industry for the manufacturer, seller and consumer. The aims and objects of the institute were signed by an executive of each of the subscribing members.

The American Water Meter Institute was organized by manufacturers of water meters for the purpose of co-operation with customers and all others who are interested in promoting the welfare of the water works industry.

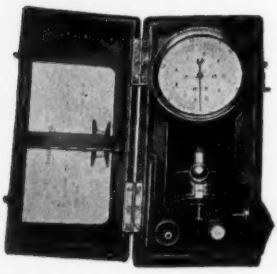
Any manufacturer of water meters whose business is conducted principally in the United States is eligible to membership.

Tachometer

(*Tobe Deutschmann Company*)

THE Tachometer recently imported by the Tobe Deutschmann Company is one of the most complete instruments of this type available at a moderate price.

The instrument is constructed with four variable speeds, ranging from 30 to 4000 R.p.m.



Four different types of direct drives are provided as well as an extension shaft and grooved wheel with cord, so that the instrument may be connected where the ordinary drive cannot be used.

Instruments of this type are almost invaluable in the modern factory or in engineering departments. They are also useful in garages and electrical repair shops.

In screw machine work, they are useful for determining cutting speed. In the factory, the speed of motors, counter shafts and other type drives may be readily determined.

In the machine shop, they can be used for determining the cutting speed in lathe work by pressing the friction wheel against the periphery of the work which is being turned up in the lathe. In motor testing they may be used to determine speed of apparatus under tests.

In the operation of the Tachometer, the proper point should always be used. For velocities up to 500 revolutions per minute, a steel point should be used. For velocities over 500 per minute, a rubber point should be used. For measuring the revolutions of a spindle, a rubber sleeve should be used. For very thin shafts a rubber funnel type should be used. For measuring peripheral or belt speed, a friction wheel should be used.

Where the speed of the spindle is not known, the speed range selected should be the instrument's maximum. If the speed is low, the instrument may then be adjusted to the range which gives the best dial reading. In taking measurements, the tachometer spindle and shaft should be kept in line, the tachometer being pressed lightly against the shaft.

The following formula should be used to determine the revolutions of the pulley or shaft when it is necessary to use the friction wheel.

If the diameter of the pulley or shaft upon which the wheel runs is known, the number of revolutions may be determined from $v=n.d/D$, where "d" the diameter of the wheel equals 38.2 mm., D the diameter of the pulley or shaft, and "n" the revolution.

In those cases where the end of the shaft is not accessible and the friction wheel likewise cannot be applied directly, the cord supplied with the instrument should be placed over the shaft and the grooved wheel respectively. In this case the number of revolutions may be obtained from the equation $v=n.dn/d$, dn being the diameter of the friction wheel measured at the bottom of the groove, viz. 31.8 mm.

Portable Pressure & Draft Indicator

(Askania Werke, A. G.)

THIS instrument is used for traverse measurements of pressure and draft in gas and air lines, mains, containers, stacks, etc.

The measuring element is a very sensitive metal membrane, which as regards accuracy, dependability and uniformity is unsurpassed. The use of the metal diaphragm in place of the measuring liquid assures it against freezing. The volume of the diaphragm is very small, so that even with a full stroke practically no gas movement results and therewith a clogging with dirt is prevented.

The movement of the diaphragm is transmitted through a well balanced gearing to the indicator arrangement, which moves a pointer.

The deflection of the pointer with draft indicators is from right to left and with both forms of measuring starts at zero.

The pointer moves over a scale which has the limits given below:

—50 to ± 0 mm. water	0 to + 100 mm. water
—25 to + 25 " "	0 to + 250 " "
—20 to + 5 " "	0 to + 500 " "
0 to + 50 " "	0 to + 1000 " "

The divisions are easy to read. The subdivision of the scale will be carried out if desired. It is essential though that the lines are not too close together as in this manner the accuracy is decreased rather than increased.

The housing of the instrument is pressed from brass sheet and is built dust-proof. The cover has the glass screwed and cemented in, and is screwed to the lower part of the case. The instrument is provided with a ring for carrying.

Corrections, which are occasioned by the pointer deviating from the zero point, can be made by means of an adjusting screw which is above the scale.

Palo Acid-Alkalimeter

(Palo Company)

THE Palo Acid-alkalimeter determines pH (acidity and alkalinity) directly, continuously and automatically. It serves a double purpose in that it is very satisfactory both as a laboratory and plant process control instrument. It is extremely desirable in the latter capacity since it is simple to operate and does not require the services of an expert to make the readings. Furthermore if electrodes are placed in tanks, vats, etc., located in various parts of the plant and connected by wire to the indicator, the acidity or alkalinity of the contents of the tanks or vats can be read off on the indicator located in the laboratory or some other convenient place.

Titration of an acid with a base, is easily carried out by means of the Acid-Alkalimeter. As an example, suppose we wish to know the number of grams per liter of acid in a solution of unknown strength. (A typical case would be to find the amount of acetic acid in vinegar.) A known volume (say 100cc) of the solution to be tested is placed in a flask or beaker into which are placed a suitable indicating electrode and a salt-bridge connecting to a reference electrode. The two electrodes are connected to the "X" binding post of the Alkalimeter, and

the latter is correctly adjusted to read pH units directly upon the upper scale.

A solution of alkali of known strength is then slowly added from a burette, the solution being stirred constantly, and readings of the pH of the solution are made simultaneously with readings of the number of cc's of alkali added.

Titration of a base with an acid is an exactly similar procedure.

The reading of the milliameter is then dependent upon the potential to be measured. In order to find out the value of the potential in volts, a switch is arranged to put a known variable potential in place of the unknown potential, and this is then adjusted so that the milliameter reading is the same, whether the known or unknown potential is used. Another position of the switch indicates by means of an ordinary voltmeter the value of the known, which is therefore equal to the unknown potential.

By specially adjusting the instrument it is possible to make each division of the milliameter correspond to one unit of pH, provided certain kinds of electrodes are employed. After this adjustment has been made, the upper scale of the meter, which reads directly in pH units, may be used.

The illustration shows the arrangement of the meters and control knobs upon the panel. The meter M is both the milliameter and the voltmeter. The switch S, when pushed upward connects the voltmeter to the known potential; thus the meter M reads in volts (lower scale) the known potential. This is adjustable from zero to 1.5 volts by means of knob K.

When the switch S is in the middle position, the meter M is connected to the plate circuit of a vacuum tube, and the reading is dependent upon the known potential; i. e., the position of knob K. The actual value read upon the scale of the meter depends upon the adjustment of the instrument, which is made by means of knobs A, B and C.

When the switch is pushed downward, the meter M is still connected to the plate circuit of the vacuum tube, but the reading is dependent upon the unknown potential.

Knob B adjusts the filament current of two vacuum tubes, and the value may be read upon meter I. Any suitable value of current may be used, up to 0.95 amperes. This value should never be exceeded, as the result would be to damage the vacuum tubes. A value of 0.80 amperes is usually satisfactory. The current should be kept constant as long as the instrument is in use.

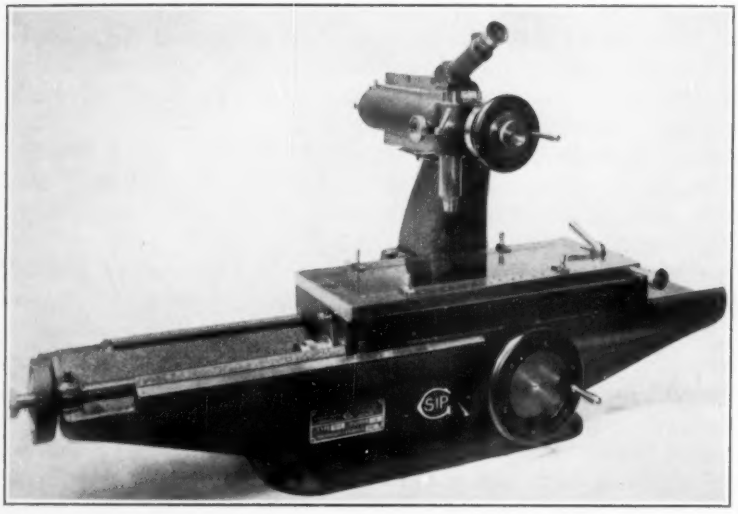
Knobs A and C regulate the relation between the meter reading and the known or unknown potentials. Directions for adjusting the meter to read pH directly are given upon the inside of cover of box.

A Two-Co-ordinate Measuring Machine

(The R. Y. Ferner Co.)

THE latest addition to the line of measuring machines made by the Societe Genevoise d'Instruments de Physique of Geneva, Switzerland, is one designed to measure in two co-ordinates at the same time. In one direction measurements of 16 inches (400 mm.) are possible; in the other direction measurements of 4 inches (100 mm.) can be made.

The bed of the machine has very accurate straight-ways, of the V and flat type, on which the carriage of the machine is moved under the action of an accurate micrometer screw. This screw has a micrometer head at the left end, which is graduated to 0.01 mm. or to 0.0005 inch, as preferred, and is read to one-tenth of these divisions by means of a vernier



index. This vernier index is not stationary, but can be shifted slightly back and forth under the action of a lever system at the back of the machine, which has a steel finger at its opposite end arranged to follow the variations in a curve templet attached to the carriage of the machine. The curve of this templet has been cut in accordance with the measured errors of lead of the micrometer screw in place in the machine. The ordinates of the curve have been calculated so that the motion imparted to the steel finger, when transmitted to the vernier index, will shift the index just enough to compensate for the error of the micrometer screw at that point.

By this compensating system it is possible for the makers to guarantee the error for any measured distance throughout the entire length of the screw to be less than 0.002 mm. or 0.0001 inch.

The micrometer head at the left end of the screw is enclosed in a heavy shield except at the point of reading to protect it from any accidental injury. The screw is not turned by manual rotation of the micrometer head, but by a hand wheel placed at the front of the machine convenient to the right hand of the observer. The shaft of this wheel is geared to the micrometer screw by helical gears, designed to rotate the screw once to two turns of the hand wheel, thus making the latter a sensitive means for making accurate settings.

Measurements in the other co-ordinate are made by a similar screw with automatic compensating device which moves a slide carried on the upright arm or pedestal at the back of the machine on which the microscope is mounted. Readings of this movement of the microscope are made to the same degree of accuracy as of the table.

The microscope is of the "bent" type, i.e., with a prism mounted between the eyepiece and the objective to permit tilting the eyepiece conveniently for the user when sitting at the machine. The microscope can be focused by means of a rack and pinion, for which adjustment a clamp is provided. Two objectives and three eyepieces furnished with the instrument give total magnifications of 7.5X, 11.1X, 11.4X, 16.7X, 22.5X and 33X, a range expected to be sufficient for most uses of the machine. A reticle of parallel spider threads is provided in the field of the object to be measured. A goniometric eyepiece is also furnished for the microscope for the reading of angles.

A large opening is cut lengthwise of the table and an adjustable mirror is provided below, set at an angle, for illuminating photographic negatives from below or to throw into relief any object placed on the glass plate set in a frame on the table. This frame is pivoted at one end, while at the other end an adjusting screw and clamp are arranged to make easier the alignment of any object to be measured parallel with the line of motion of the table.

To provide for movement of the table in both directions and eliminate backlash an ingenious form of counter nut is assembled with the usual nut. The useful length of the nut engages 29 threads of the screw, while the counter nut engages 19 more, giving a total of 48 threads or 96 mm. on the metric machine.

Because of the dimensions, the variety of accessories and range of magnifications the machine will have a wide variety of uses. In addition to the measurement of photographs of spectra or astronomical photographs, it may be used for measurement of any type of negative or photographic print or tracing—such as oscillograph curves, seismographic records, recording instrument tracings, or hysteresis loops, and also for checking gages of special form, templets, cams or any small metal parts which have sharp edges on which settings of the microscope can be made.

Krupp Mikrotast Gauges

(Coats Machine Tool Co.)

FOR checking work during and after the process of manufacture in their widely ramified divisions, the Krupp Steel Works of Germany have designed what they term "Mikrotast Gauges," representing a new departure in gauging practice.

Set either to a master plug or master ring, they show in plain figures on a dial 2½ inches wide, deviations from this master.

The indicating mechanism or "Mikrotast" proper is of the knife-edge type. To insure a clean sharp seating, one knife-edge is in two abutting sections instead of being cut from the solid. This mechanism transmits the axial movement of the work contact rod into a swinging movement of the pointer. For English standards a scale of 48 divisions has been adopted in the following graduations, .00004-inch (not for free-hand operation—to be used in fixed supporting stands only) .0001-inch, .0002-inch, .0005-inch and .001-inch. Mikrotast 48 graduated .0001-inch would thus have a scale range of .0048-inch over a pointer travel of 2½ inches or an amplification of approximately 500 diameters.

Mikrotast fixed internal gauge with interchangeable plates and extension rod.

MIKROTAST SADDLE GAUGES

This Mikrotast fits all external, internal, taper and thread gauges. For external inspection, a unit in saddle form is used with two angular measuring flats. These measuring flats are held by friction plates and can be slid towards the center of the saddle. That this means a saving of a large number of positive gap gauges is best realized by stating that eleven saddles cover the wide range from ¼-inch to 40-inch diameter. For example, one of the smaller saddles will cover the range of from 1-inch to 1¾-inch, a medium size saddle will be suitable for any size between 5-inch to 8-inch, whereas the largest saddle will cover the range from 32-inch to 40-inch. These measuring flats are made of Krupp "Nitrierstahl," an alloy of exceptional hardness and wear-resisting qualities. This is obtained by a special "nitrating" process and only a special carborundum wheel will touch this material.

From ¼-inch and up to 8-inch diameter the angle of these measuring flats or plates is approximately 39 degrees (38 degrees 56 minutes to be exact). At this angle, the path travelled by the work contact rod equals any change in the diameter of the work. In other words, the ratio is 1 : 1. A three-point contact on the work is thus obtained which is, of course, vastly superior to a two-point contact for indicating deviations from a true circle.

The gauge, after having been set to a master, is placed upon the work, seating itself by its own weight only, and will thus register any variation in size. Wet grinding operations will not affect the Mikrotast because the gauging point is above the work and thus not exposed to the grinding fluid. Red limit pointers are provided on the scale, adjusted by means of a knurled screw and locked in any desired position by means of a lock-nut.

Shows application of illustration above.

For diameters exceeding 8-inch diameter and up to 40-inch diameter, saddles of 90 degree angle are used and here the path travelled by the work contact rod would be five times the diameter variation. An ordinary Mikrotast used in connection with 39 degree saddles would thus indicate .0005-inch instead of .0001-inch if used in a 90 degree saddle. Consequently, Mikrotasts are adjusted for this 5 : 1 ratio of 90 degree saddles and are marked "for 90 degree saddles only."

Mikrotast saddle gauge with 36 deg. angle for checking the lands of a spiral reamer with five flutes.

These large saddles are especially useful —replacing micrometers, expensive straight edges and other devices—during spherical, hollow or cylindrical grinding operations, also for checking camber and wear on rolls, where accuracy is of great importance. The ratio of expansion of the cast iron body of these gauges is practically the same as used in the manufacture of rolls whereas other appliances are often made of a lighter material to reduce the weight, resulting in errors due to temperature changes and influencing in turn the accuracy of the measuring operation.

For checking broken surfaces, for instance, checking over the lands of a spiral reamer, the angle must be in accordance with the number of flutes, five teeth for instance requiring a 36 degree angle. In this latter case the dial reading must be multiplied by a constant (.9 for a 36 deg. angle).

Mikrotast gauge for measuring pitch diameter on three fluted tap.

MIKROTAST EXTERNAL TAPER AND THREAD GAUGES

Two variations of the Mikrotast saddle gauge are Mikrotast external taper gauges and Mikrotast thread gauges. The former consist of two saddle gauges connected by a bridge piece, with special end stop. B. & S., Morse and metric tapers may thus be checked with great accuracy.

For checking pitch and core diameters of external threads an ordinary Mikrotast saddle is equipped with suitable locating pieces and gauging points. Pitch, core and outside diameters of right and left-hand taps with three or four flutes from ¼-inch diameter upwards are checked by the attachment to the Mikrotast of an annular frame with two interchangeable fixed locating points and one moveable gauging point. A great advantage of these gauges is a constant and even pressure during the gauging operation, due to the fact that the Mikrotast hangs by its own weight.

MIKROTAST INTERNAL GAUGES

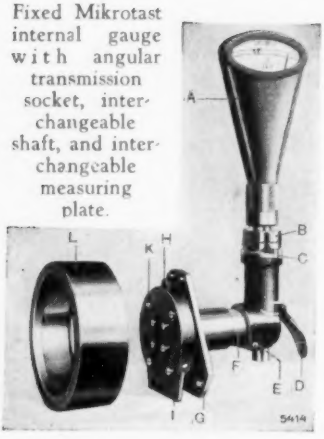
Internal gauging offers more difficulty than external gauging. For internal diameters a standard adapting unit with four (not three) contact points has been chosen, one of which is moveable, the remaining three being stationary points of abutment. Krupp internal Mikrotast gauges are made as fixed gauges, preferred for mass production of one or two lines, and self-accommodating, used where a greater variety of work is handled.

With Krupp Mikrotast internal gauges it is possible to control any and every part of a bore of practically any diameter and depth—blind holes right down to the bottom. (Ordinary plug gauges only give a reliable check of the bore to a comparatively shallow depth.)

For checking holes of medium depth both the fixed and self-accommodating type of internal Mikrotast can be fitted with an angular adaptor. This will be found useful while checking work on a grinder, considerably reducing the movement of the tailstock under this operation.

For checking deep holes only somewhat primitive methods were available, requiring great skill of operation. By connecting a special self-accommodating gauge and Mikrotast to long extension rods, suitable for diameters of 2-inch upwards, each extension being about 50-inch in

Fixed Mikrotast internal gauge with angular transmission socket, interchangeable shaft, and interchangeable measuring plate.



Mikrotast internal gauge for double-flanged roller bearings.

length, a most efficient combination for checking deep holes of practically any depth has been created.

As an example of practical adaptation of the instruments we mention the operation of checking moulds for casting long tubes. If these moulds are contracting or expanding in any particular spot the tubes will adhere to those places and thus spoil both the mould and the tube. A Mikrotast internal gauge for checking moulds for casting long tubes as previously described has a range of .096-inch for one setting, when using a Mikrotast 48E with .002-inch graduation.

Mikrotast internal gauges may also be used for checking the bore of the outer ring of double-flanged roller bearings, an angular socket and pistol grip lever making it possible for the flange to be passed.

Mikrotast internal gauges are also made for checking internal tapers and for checking the pitch diameter of nuts from ½-inch to 2-inch, in one adaptation, and for internal threads above 2-inch in another.

There are still other applications for checking lead on taps, with or without test bench. Taper or cylindrical rollers may be checked on a fixture with electrical signalling device, showing a red light when roller is undersize and a green light when roller is oversize, with no light showing when roller is within set tolerance limits.

Hobs, spur, worm and bevel gears, racks, etc., may be checked with Mikrotast special appliances. The Mikrotast itself may be used right side up or upside down or in horizontal position without the slightest effect on the accuracy of the reading obtained.

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Every purchaser pays the cost of selling him the goods he buys. It is the seller's business to use every means to keep the selling cost low and make the service worth all that it costs.

Description Of Linear Dividing Machine

(Gaertner Scientific Corporation)

THE machine is designed to operate entirely automatic and will permit the dividing of scales of practically any description in metric or in inch system, from the finest microscopic rulings with diamond point to heavy commercial scales on flat, beveled or curved surfaces. The machine is operated by a ¼ H.P. motor and provision is made for three different speeds. At the highest speed about 30 lines can be ruled per minute.

The bed frame of the machine is 80 inches long and is made of high grade cast iron, so designed as to give the greatest stiffness without undue weight. After rough machining the bed frame is heat treated in order to remove any strains and prevent warping. The bed casting has a three point support on which it is machined and accurately straightened. The guiding surfaces form a 60° prism on one side and a flat surface on the other. The rear side of the bed frame is extended in a prismatic guide on which the micrometer microscopes can be clamped so as to reach any part of the machine. On the same side is mounted the tracing mechanism and the shaft with gear and lever mechanism for operating the machine.

The carriage is 41 inches by 9 inches and is made of the same high grade cast iron as the bed frame and is carefully fitted to the bearing surfaces. The weight of the carriage is taken up to the largest extent by four ball bearing rollers mounted on adjustable springs and running on steel tracks accurately parallel to the guiding surfaces. The spring pressure on the rollers is easily adjustable so as to provide for the different weight of work which is placed on the carriage, and to always assure the least possible resistance in moving the carriage.

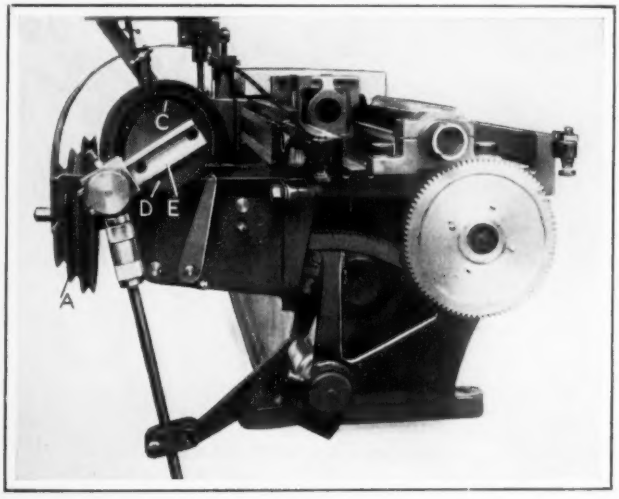

Fig. 1

The lead screw is cut of a high carbon steel selected especially for this purpose, which is of the finest and extremely uniform structure, assuring absolute straightness and long wear. The pitch of the screw is 1 mm. The angle of the thread is 50° which angle has proven by experience most satisfactory for best wear. The expansion coefficient is .000011 per unit length per degree Centigrade.

The screw is calibrated and corrected for at 20° C. against a standard meter bar which itself was calibrated against the standard of the United States and the standard of the Bureau International des Poids et Mesures, Sevres.

Any small progressive errors of the screw are corrected in the usual manner by means of a guide bar in front of the machine against which the nut guide is bearing. The periodic errors of the screw have been well corrected and within an accuracy of 0.002 mm. or 0.00008 inches.

The machine is operated from the main shaft, Fig. 1, which by means of a worm and a worm wheel transmits the motion to the driving shaft "A" see Fig. 3, and which in turn transmits the motion to the different mechanisms i.e., spacing of divisions, tracing of lines and actuating the automatic stop device. The worm is mounted on the main shaft engaging in the worm wheel and trans-

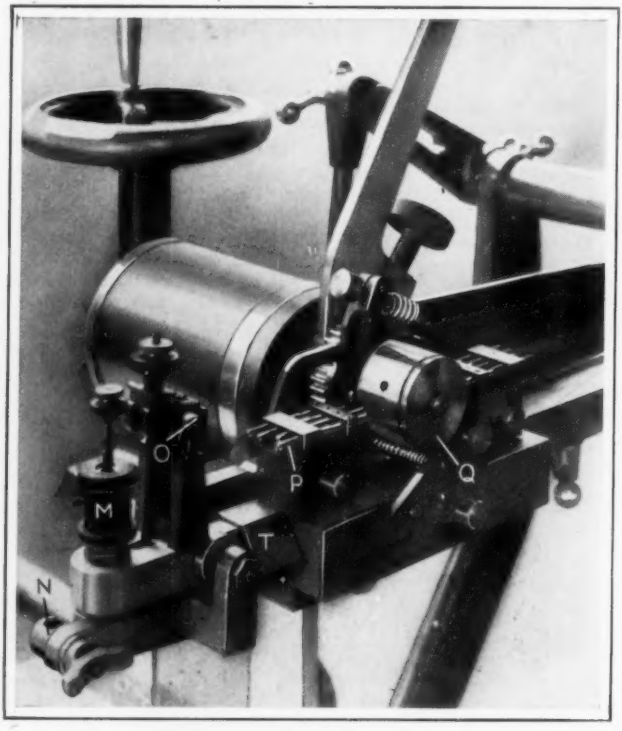

Fig. 2

mits the power of a ¼ H.p. (1200 R.p.m.) motor by means of a 3-step cone pulley in a ¼-inch round belt. The worm shaft bearing is substantially hinged and may be brought to mesh with the worm wheel by means of handle "H" (see Fig. 4).

The driving shaft of "A" carries a disc "D" (see Fig. 1) to which a variable lever arm "E" adjustable for the amount of stroke, is permanently attached. The lever arm has a scale engraved upon it for convenience in setting the lever fulcrum to different radii. The transmission gears transmit the motion to the lead screw. The smaller gear is intended for use in coarse spacings and when more than one revolution of the screw is required, while the second gear is intended for finer spacing. The gear sector may be easily brought to mesh with either of the two gears.

The spacing mechanism consists of three individual discs of which two are rigidly attached to the lead screw. The automatic stop disc is mounted independent of the screw and regulates the amount of rotation of the screw. A pawl is attached to a disc which engages with the ratchet wheel when the disc is rotated clockwise and relieved when turned in the opposite direction. On one side of the disc a hardened steel stop is permanently attached, while the other stop is mounted on another disc, rotatable in reference to the first disc.

The tracing mechanism is supported on a substantial iron bracket (see Fig. 2) upon which it can be shifted back and forth to the desired position, and raised and lowered by means of the elevating screw arrangement "R."

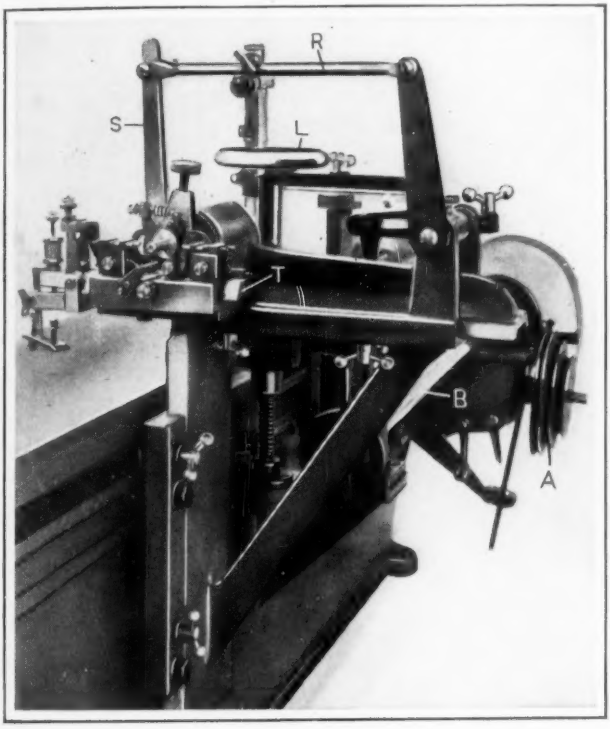

Fig. 3

The pressure is applied to the engraving tool by means of a helical spring contained in compartment "M," adjustable by a nut. Four springs are furnished with the machine and may be interchanged, depending upon the fineness of the lines desired. In ruling lines of microscopic fineness, the spring contained in compartment "M" is removed and the weight of the tool and supporting lever is counter-balanced by a light helical spring placed on the projecting screw, adjustable by a nut. The rocker arm "O" serves the purpose of lifting and lowering the tool and is operated by the excess motion of the rack at the beginning and the end of each stroke. The set screws "P" regulate the length of lines and are tightened in place by screws. The drum "Q" governs the type of ruling desired. Five drums are furnished with the machine, each giving a specific type of ruling.

Motion of the lever arm "A" (see Fig. 3) is transmitted by means of a friction clutch at the center of the lever "S" to a spur gear which engages in a

rack mounted on slide "T." The rack is not rigidly attached, but has a small lengthwise play utilized for the operation of the rocker arm for raising or lowering the engraving tool. The friction in the slide is needed for lifting the tracing tool and must be sufficient to overcome the spring pressure of the tool. The mechanism permits the ruling of lines up to 1-inch in length. The tracing mechanism is mounted on a substantial swivel and may be set at any angle in reference to scale and index up to 30° plus or minus from the horizontal.

The automatic stop consists of two graduated wheels "U" (see Fig. 4) enclosed in a housing and a release lever. Both wheels are divided into 100 parts, each division of the one wheel being equivalent to one line ruled, while one division of the other is equivalent to 100 lines ruled. Each wheel carries a hardened steel disc with a notch in which a lever engages when the wheels are in the neutral position.

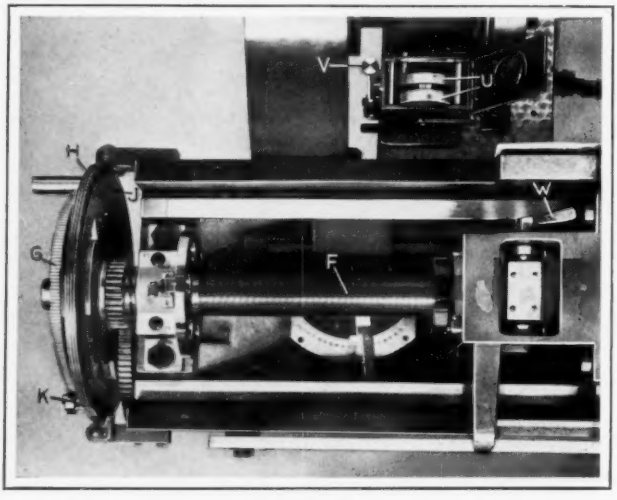

Fig. 4

The wheels are rotated by pawl and ratchet wheel system operated by a connecting arm working on a cam of the main shaft. If it is desired to rule a meter bar in millimeters, the total number of divisions required is 1000 (or 1001 lines). To set the automatic stop, set the first wheel at zero and the second wheel at 10. When the 1000th millimeter is ruled the lever engages in the notch of the automatic stop, thus releasing the transmission of the machine causing the machine to stop.

A long steel bar placed inside of the machine operated by means of a lever working on the scale at the extreme left of the machine, serves the purpose of correcting the screw for various temperature graduations. The scale is divided into degrees centigrade of which each division is equivalent to 2 degrees. In as much as the screw has been corrected for 20° C., the arc for total length at this temperature is zero. By merely setting the index on the temperature scale corresponding to the temperature of the machine, the total length error is automatically compensated.

A small lever "W" projecting on one side of the nut serves the purpose of disengaging the nut from the threads of the screw, thereby permitting free motion of the carriage independent of the screw. The carriage has four adjusting screws accessible from the top which are intended for maintaining the weight of the carriage on the guides constant.

Catalogue Library

Check any of the publications you want. Remove the page and send with coupon to INSTRUMENTS. They will be forwarded to you without cost or obligation.

Acid-Alkalimeter

The Palo Acid-Alkalimeter for pH determinations is described in recent literature published by the Palo Company, 153 West 23rd St., New York, N. Y.

Bausch & Lomb Magazine

The July-August issue of this paper is at the same time the anniversary number and contains very interesting articles: A Short History of Bausch & Lomb; Science and the B. & L. Microscope; That Eyes may see Better and Farther. The paper is published by the Bausch & Lomb Optical Company, Rochester, N. Y.

Binoculars and Telescopes

A catalogue of Binoculars and Telescopes has recently been issued by W. Watson & Sons, Ltd., 313 High Holborn, London, England.

Business Chemistry

Published by Skinner, Sherman & Esseler, Inc., Boston, Mass. Some of the short articles cover modern Alchemy, Leisure for suffering, Business saved.

Blending Calculator

Catalog 947 of the C. J. Tagliabue Mfg. Co., 18 Thirty-third St., Brooklyn, N. Y. is a handbook covering the use of the Tagisom Blending Calculator.

Camera—Pocket Roll Film

Price List No. 1127 covers the Leica Pocket Roll Film Camera of E. Leitz, Inc., 60 East 10 Street, New York, N. Y.

Cameras, Lenses and Accessories

W. Watson & Sons, Ltd., 313 High Holborn, London, W.C.I., England, have issued an illustrated catalogue of Photographic Cameras, Lenses and Accessories.

Chemist Analyst

The July issue of The Chemist Analyst issued by the J. T. Baker Chemical Co., Phillipsburg, N. J. has an interesting article entitled "An Improvised Photomicrographic Apparatus."

Dynamometers

"The Place of Field Testing in Industry" is the title of a booklet published by John Chatillon & Sons, 85 Cliff St., New York, N. Y.

Dynamometers

GEA 544 published by the General Electric Company, Schenectady, N. Y., illustrates and describes their dynamometers.

Engineers First—Salesmen Afterwards

is the title of a recent mailing of the Bakelite Corporation, 247 Park Ave., New York, N. Y.

Experimenter

The General Radio Company, Cambridge, Mass., cover the following articles in the August issue of the Experimenter Magnetostriction oscillators; Type 330 Filter Sections and Silicon vs Nickel in Transformer Design.

Gauges—Pressure and Vacuum

Sections 1 and 2 of the Catalogue of The Budenberg Gauge Co., Ltd., Broadheath, England, covering pressure and vacuum gauges has recently been issued. Section 3 covers Pressure gauge testers, Mecurial Columns, etc.

Graphic Meters

Bulletin 528 of The Esterline Angus Company, Indianapolis, Ind., covers results obtained with Rapid Chart Feed Graphic Meters.

Just Why the De Vry takes Better Movies

is the title of a bulletin issued by The De Vry Corporation, 1111 Center St., Chicago, Ill.

Let Tag Instruments Stand Back of Your Milk

Bulletin 948 of the C. J. Tagliabue Mfg. Co., 18 Thirty-third Street, Brooklyn, N. Y., covers the application of Tag instruments in the Dairy.

Minimeter—A Water Column Micro Gauge

Pamphlet Baro 145E issued by the Askania Werke, Kaiserallee 87-88, Berlin-Friedenau, Germany, describes and illustrates the minimeter—a water volumn micro-gauge accurate to within 1/100 of a millimeter of water. This leaflet is printed in English.

Oil Refining Bulletin

Bulletin No. 918B published by the C. J. Tagliabue Mfg. Co., 18 Thirty-third St., Brooklyn, N. Y., covers the application of Tag instruments in the oil refining industry.

Photometer

The New Model Ives Tint Photometer is covered by a recent leaflet of the Palo Company, 153 W. 23rd St., New York, N. Y.

Psychrostat

The Park Spray Psychrostat—a rugged but sensitive Humidity Regulator is the subject of Form 226 issued by Parks-Cramer Company, Boston, Mass.

Pyro Pyrometers

A recent mailing of the Pyrometer Instrument Company, 50 Howard St., New York, N. Y., gives a number of testimonials on their optical pyrometer.

Pyro Radiation Pyrometers

A new bulletin issued by Dr. Rudolf Hase, Hanover, Germany covers the Pyro radiation pyrometers, sold in this country by the Pyrometer Instrument Company, 50 Howard St., New York, N. Y. This bulletin is printed in German.

Refinery Supply Catalogue

The Catalogue of the Refinery Supply Co., Tulsa, Okla., covers the Ac-Me Pocket Calculator, Ac-Me Recording Gravitometer, Ac-Me Gravity Balance, Ac-Me Vapor Tension Bomb.

Recording Gauges

A recent catalogue of the Budenberg Gauge Co. Ltd., Broadheath near Manchester, England, covers their recording pressure gauges.

Relays

The N. C. S. Sensitive Relays, Instantaneous Type for over current, under current, over voltage or leakage, circuit closing or circuit opening types are covered in Bulletin RL. 14a, Nalder Bros. & Thompson, Ltd., 97a Dalston Lane, London, E8, England.

The N. C. S. Directional Relays for Alternating current circuits is covered by Bulletin RL 19.

Resistance Thermometers

Catalog No. 93 of the Brown Instrument Company, Wayne & Roberts Aves., Philadelphia, Pa., fully describes the applications and types of Brown Resistance Thermometers as applied to modern industry.

Rotoscope

The Ashdown Rotoscope, for slow motion investigations, is covered by a recent leaflet of A. J. Ashdown, Ltd., 119 Victoria St., London, S.W.I., England, may be obtained from the Commercial Engineering Laboratories, Detroit, Mich.

Sampling & Gauging Instruments

Catalog 957 of the C. J. Tagliabue Mfg. Co., 18 Thirty-third St., Brooklyn, N. Y., covers the following: Weighted Bottle, Weighted Beaker, Drum Thief, Water Indicator, Gauging Thermometer, Bob and Tape and Double Rule Gauge.

Sperryscope Vol. 5, No. 9

Published by the Sperry Gyroscope Company, Manhattan Bridge Plaza, Brooklyn, N. Y., contains the following interesting articles: The Gyroscope and Maritime Safety; Gyro-Compass Model Exhibited in the Museum of Peaceful Arts; The First Report of a Naval Officer covering the Sperry Gyro-Compass; A New Type of Steering Equipment.

Steam Consumption Test Reports

Bulletin No. 955 issued by the C. J. Tagliabue Mfg. Co., 18 Thirty-third St., Brooklyn, N. Y., shows the steam savings effected by Automatic controllers on Dye Kettles.

Tachometers

Catalogue Section 23, Budenberg Gauge Co. Ltd., Broadheath near Manchester, England, covers the various tachometers manufactured by this Company.

Temperature Control

The Premier Mfg. Co., 1908 Homewood Ave., Baltimore, Md., has issued a leaflet on a dependable automatic thermostat for controlling temperature on Gas, Steam or Oil heated appliances.

Temperature

Bulletin No. 959 of the C. J. Tagliabue Mfg. Co., 18 Thirty-third St., Brooklyn, N. Y., is entitled "Temperature—the most vital factor in modern Laundry Operations."

Temperature Instruments

TAG Temperature Instruments for the New York State, July 1928 Milk Regulations is the title of Bulletin 961 issued by C. J. Tagliabue Mfg. Co., 18 Thirty-third St., Brooklyn, N. Y.

Tools—Measuring

The Brown & Sharpe Company, Providence, R. I., have issued the following:

25M-6-28 No. 276 Tubular Inside Micrometers.

50M-5-28 Nos. 60 & 62 Micrometers.

50M-12-27 No. 751 Handy Block and Clamp.

Rotational Inertia Apparatus

Bulletin 113 of the Gaertner Scientific Corporation, 1201 Wrightwood Ave., Chicago, Ill., lists their rotational Inertia apparatus.

Thermometers

The Budenberg Gauge Company, Ltd., Broadheath, England, have issued catalogue Section 27 covering their steel tube mercury type thermometers for temperatures up to 1000° F.

Thermometers—Dial Indicating

Bulletin No. 951 of the C. J. Tagliabue Mfg. Co., 18 Thirty-third St., Brooklyn, N. Y. illustrates their 5 inch dial indicating thermometers.

Transformers—Current

Bulletin T1 of Nalder Bros. & Thompson, 97a Dalston Lane, London, E. 8, England, covers the current tranformers manufactured by this company.

Transmit-O-Phone

The International Metal & Specialty Co., Berlin, New Jersey have issued a leaflet describing this simple device which can be used for determining knocks and noises in machinery, motors, etc.

Water Works Journal

The July issue of this journal published by the Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa., contains the following articles: Mount Airy and its Water Supply; Pollution of Water Supplies Serious; Equitable Distribution of Costs made possible by New Water Meter Rates; Bellefonte and its Water Department.

Wattmeters—Indicating

Indicating Wattmeters of improved dynamometer type are illustrated in Bulletin W1 issued by Nalder Bros. & Thompson, Ltd., 97a Dalston Lane, London E8, England.

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Current Literature Review

Abstracts on instruments of interest to instrument readers

The Measurement of High D. C. Potential Differences with Applications to the Calibration of Electroscopes and Electrostatic Voltmeters. W. Bender, Jl. Opt. Soc., July 1928, pp. 72-76.

An arrangement of condensers, switches, and a ballistic galvanometer is discussed, by means of which high D.C. potential difference can be measured with considerably greater precision than given by ordinary high voltage electrostatic voltmeters. Simple equations of design are derived, which if scrupulously followed will give 0.5% accuracy no matter how high the D.C. potential difference. The application of this method to the calibration of an electroscope is given in detail.

An Improved Permeameter for Testing Magnet Steel. B. J. Babbitt, Jl. Opt. Soc., July 1928, pp. 47-58.

The increasing use of cobalt steel in the manufacture of permanent magnets has created a need for a permeameter that is capable of determining accurately the magnetic properties of such steel in bar form. The common commercial permeameters are not capable of producing the high magnetizing forces required for this purpose. Commercial permeameters are chiefly of two types, the yoke type and the Burrows type. The latter is difficult to operate and requires an experienced operator for a reasonable output; it cannot be adapted to the testing of cobalt steel unless it is practically rebuilt throughout. The permeameter described in this article was developed by the Magnetic Materials Division at the Hawthorne works of the Western Electric Company to overcome the chief objections common to present commercial permeameters.

Design and Construction of Large Water Meters. (Projektierung und Ausfuehrung grosser Wassermesser.) Siemens Zeits, May 1928, pp. 309-315.

The Venturi tube for water measurement is taken up as it applies to practice.

Overcoming the Irregularities in Resolving Power of the Dark Field Microscope. (Beseitigung der Unstetigkeiten im Aufloesungswermaegen der Dunkelfeldmikroskope.) J. Groeneveld Zeits Instrumentenk, July 1928, pp. 349-352.

The problem is considered mathematically.

Severe Optical Arrangement for Observing the Telescope Bubble with Levels. (Ueber einige optische Vorrichtungen zur Beobachtung der Libellenblase bei Nivellierinstrumenten.) K. Luedemann. Allgemeine Vermessungs Nachrichten, May 2, 1928, pp. 286-290.

Several arrangements are discussed and the results obtained with them are given.

On the Mutual Orientation of Aerial Photographs by Means of Gnomonic Projection. (Ueber die gegenseitege Orientierung von Flugaufnahmen mittels gnomonischer Projektion.) C. Schmidt. Zeits fuer Vermessungsen. June 1, 1928, pp. 337-356.

The conversion of photogrammetric space coordinates into the earth surface coordinate system are taken up in this installment.

The "Acid-Alkalimeter"; a Direct-Reading pH Meter. K. Goode, Jl. Opt. Soc., July 1928, pp. 59-71.

Methods of determining pH of solution are given. The various instruments designed by the author for this purpose are mentioned. The final instrument designed by him is described in some detail.—M.B.R.

Tests and Inspection in Rubber Footwear Factories. Rubber Age, July 25, 1928, pp. 433-434.

The subject is briefly considered.—M.B.R.

Plasticity and Elasticity of Rubber. A. Van Rossen and H. Van der Meyden. Rubber Age, July 25, 1928, pp. 438-440.

Reprint of paper presented before the International Congress of Testing Materials at Amsterdam, Holland, Sept., 1927.

The instrument for making the measurement is described.—M.B.R.

Balancing Temperature in Shell Type Transformers. G. D. Clark. Power, July 17, 1928, p. 113.

The temperature distribution in these transformers is briefly discussed.

Investigation of a Lens by Graphical Methods. J. P. C. Southall. Jl. Opt. Soc., July 1928, pp. 1-14.

Reprint of a paper delivered before the Optical Society of London. The article covers the following subjects: the chief ray and the construction of its path, the focal points of the two component optical systems, and the focal lengths, the focal points of the compound optical system, the magnification ratio in the Sogittal Section, the refracting power and the image equations.—M.B.R.

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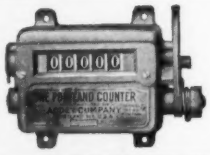

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The Emscher Leveling Rod (Die Emscher Nivellierlatte). O. Hellwig. Allegemeine Vermessungs-Nachrichten, July 25, 1928, pp. 481-483.

The construction of the rod is described and illustrated.

The String Level (Die Schnurlibelle). A. Schutte. Allegemeine Vermessungs-Nachrichten, July 25, 1928, pp. 483-484.

The instrument is briefly described.

Magnetic Surveying. W. H. Fordham. Oil Engg. & Tech., June 1928, pp. 169-171.

A brief discussion on this subject with reference to various instruments.

The Effect of Leaky Exhaust Valves with Diesel Engines and the Observations of the Value During Operation by Means of Thermocouples. (Die Wirkung undichter Auslassventile bei Dieselmaschinen und die Beobachtung der Ventile waehrend des Betriebes durch thermoelemente.) O. Dinkela. Siemens-Zeits, June 1928, pp. 382-384.

The use of the thermocouple for observing the operation of the exhaust valves is briefly discussed.

Further Developments in Photo-electric Photometers. C. H. Sharp and H. A. Smith. Trans. Ill. Eng. Soc., April 1928, pp. 428-451.

Summary of progress in developing photo-electric photometers in electrical testing laboratories. Four separate systems are described, all of which have been given practical application and have shown their practical adaptability to commercial photometry. Abs. Bull. Kodak Research Lab.

Results of Practical Experiences in Photo-electric Photometry. W. F. Little and C. E. Horn. Trans. Ill. Eng. Soc., April 1928, pp. 419-427.

Greater speed and accuracy are attained than with the visual photometer. The photo-electric cell photometer has been proved entirely practicable, and its many advantages are pointed out. Variations, due to the lamps themselves, but formerly thought to be due to errors in visual photometric observation, have been found.—Abs. Bull. Kodak Research Lab.

Photo-electric Cell Photometer. C. Deshler and H. Schroeder. Trans. Ill. Eng. Soc., April 1928, pp. 391-418.

Photo-electric cell characteristics, circuits, and applications to photometry are discussed. Various attempts to obtain proportionality of response are described. Progress in photo-electric cell photometers is reviewed. Either a micro-ammeter or a galvanometer may be used to measure the current.—Abs. Bull. Kodak Research Lab.

Preliminary Report of Measurement of Variation of Energy in the "Vita Spectrum" of the Sunshine in Kansas. J. S. Hughes and R. L. Pycha. Trans. Ill. Eng. Soc., March 1928, pp. 233-246.

Using the acetone methylene blue gauge, daily observations were made on the intensity of the "vita" portion of the solar spectrum. The results show a marked increase in the rapidity of bleaching of methylene blue in the May to October sunshine. A narrow region around 2935 mu is designated as "vita radiation."—Abs. Bull. Kodak Research Lab.

Photometry and Watt Measurements of Incandescent Lamps on Ordinary A.C. Circuits. C. H. Sharp and E. D. Doyle. Trans. Ill. Eng. Soc., April 1928, pp. 383-390.

The measurement of lumens and of electrical values is reduced to a comparison lamp which is affected similarly by all voltage fluctuations. Zero methods are used throughout. Rheostats are replaced with induction regulators. Sixty-cycle flicker was eliminated by use of a large condenser in the lamp circuit.—Abs. Bull Kodak Research Lab.

Standardization of Methods of Heterochromatic Photometry. A. H. Taylor. Trans. Ill. Eng. Soc., April 1928, pp. 361-382.

Nine different observers tested twelve color filters by means of the spectrophotometer and the flicker photometer. Integral transmission factors were computed from spectral transmission data and also measured directly with the flicker photometer. The average difference was 2.4%. The difficulties of heterochromatic photometry are reviewed and a proposal is made for a standardized method of procedure.—Abs. Bull. Kodak Research Lab.

A Device for Controlling the Rate of Cooling and Heating of the Haughton-Hanson Thermostat. J. D. Grogan, Jl. Scient. Insts., July 1928, pp. 217-219.

The Haughton-Hanson thermostat consists of a silica bulb in an electric resistance furnace and attached to a mercury relay. Expansion of air in the bulb breaks the mercury relay, which in turn breaks or lowers the current heating the furnace. The device here described consists of an electrolytic cell which delivers oxygen to the thermostat bulb at a steady rate and produces a steady fall of temperature in the bulb. By diverting the gas to a counterpoise bulb attached to the other side of the mercury relay the temperature of the thermostat may be made to rise steadily. —M.B.R.

A Simple Method of Measurement of Capacity and High Resistance by Means **of a Thermonic Valve.** G. R. Toshniwal. Jl. Scient. Insts., July 1928, pp. 219-221.

Charging a capacity by means of a suitable battery and discharging it through the grid-filament circuit, provided with a suitable grid leak, it has been found possible to determine the value of a very small capacity, by noting the change in the anode current. By a similar process values of high resistance have also been obtained.—M.B.R.

Temperature of the Under-Water Spark as Computed from Distribution of Intensity in OH Absorption Bands. E. Wilson. Jl. Opt. Soc., July 1928, pp. 37-46.

Detailed measurements of the OH-bands found absorbed in the under-water spark reveal that the system is developed in absorption almost as completely as in emission. Calculations based on intensity distribution lead to a value of approximately 5000°C for the effective temperature of the source.—M.B.R.

Testing Brine for Presence of Ammonia. C. E. Anderson. Power Pt. Engg., July 1, 1928, pp. 731-732.

The article describes simple chemical tests with simple equipment for the detection of minute traces of Ammonia in Brine.

The Herbert Cloudburst Hardness Testing Machine. Engg., July 6, 1928, pp. 28-29.

The cloudburst hardness testing machine is described and illustrated.—A. M. W.

A Single Derivation of the Working Equation of Magnetic Variometers for Vertical and Horizontal Intensity. O. C. Lester. Bulletin of the American Asso. of Petroleum Geologists, August 1928, pp. 855-860.

Derivations of the working equations of a local magnetic variometer in general use in the field are ordinarily based upon complicated theoretical considerations. The author presents a simple derivation involving nothing more than elementary physics.

Testing of Work Ropes Essential to Safety. M. R. Sumner and G. E. Balch. Elect. Rail. Jl., Aug. 25, 1928, pp. 295-296.

Tests for rope are given with results.

An Optical Recorder of Combustion Conditions. Engg. Boiler House Rev., Aug. 1928, pp. 69-70.

This article describes the "Lumograph," made by Karl Priem, Frankfurt-Oder, Germany, which provides a continuous record of the luminosity of the flame at an appropriate point in the combustion chamber.

Coefficients of Venturi Meters and Reynolds' Criterion. W. S. Pardoe. Engg. News-Rec., Aug. 28, 1928, pp. 281-282.

Results are given in graphs.

Photomicrography in Natural Color. T. S. Curtis. Jl. Amer. Ceram. Soc., Aug. 1928, pp. 609-632.

An outline of the process and technique used in the Vitaefrax Laboratory for the preparation of permanent and faithful records of ceramic and refractory body structures.

Spray Room Control with a Camera. H. E. Davis. Jl. Amer. Ceram. Soc., Aug. 1928, pp. 639-643.

The use of the camera for recording spray room applications is described and its advantages over the old method of keeping actual samples of each spray which soon forms a bulky, dusty accumulation, subject to accident and deterioration.

Exhaust Temperature as a Load Index for Oil Engines. E. C. Magdeburger. Jl. Amer. Soc. Naval Engrs., Aug. 1928, pp. 496-500.

The problem is briefly discussed.

A Thermionic Voltmeter for Measuring the Peak Value and the Mean Value of an Alternating Voltage of any Wave-Form. E. B. Moullin. Jl. Inst. Elect. Engrs., Aug. 1928, pp. 886-895.

The paper describes a thermionic voltmeter which can be used to measure the peak and mean values of an alternating wave-form. An application of the voltmeter is illustrated by curves which show the distortion produced by a 4-stage thermionic amplifier.

Theory of the Double X-Ray Spectrometer. M. M. Schwarzschild. Phys. Rev., Aug. 1928, pp. 162-171.

The geometric factors in the construction and use of the double X-Ray spectrometer are examined in detail. It is found that the resolution of the instrument is not affected by the width of the slits but that, on the other hand, the height of the slits must be limited to preserve resolution. The physical factors, namely crystal imperfection, line width, diffuseness of absorption limits, are also discussed and formulas are derived by means of which the experimental curves found with the instrument may be interpreted physically.

The Measurement of Ultra-Violet Quanta by Fluorescence Photometry. W. T. Anderson and L. F. Bird. Phys. Rev., Aug. 1928, pp. 293-297.

The relative intensities of monochromatic ultra-violet light determined throughout the ultra-violet mercury spectrum by the use of a fluorescence photometer employing widely different chemical substances were shown to check the intensities of the light given by the thermopile. The agreement between the photometric and thermopile measurements indicates that both methods may be employed for measuring accurately the energy of the ultra-violet region.

On the Precise Determination of Thermal Capacities with Particular Reference to that of Molybdenum. T. E. Stern. Phys. Rev., Aug. 1928, pp. 298-301.

It was found that a Bunsen ice calorimeter modified by the addition of a silvered vacuum jacket was capable of yielding precise values of the total heats of substances.

Review of Recent Patents

Printed copies may be obtained at the cost of 10 cents by addressing the Commissioner of Patents, Washington, D. C.

SPEEDOMETER. Guy W. Blackburn, Elgin, Ill. Pat. No. 1,679,203.

FLUID REGULATOR. Otto B. Goldkamp, San Diego, Calif., assignor of one-half to San Diego Consolidated Gas & Electric Co., and one-fourth to Selmar R. Siebert. Pat. No. 1,679,215.

GAUGE AND RECORDER. Henry F. Wright, Huntington, Calif. Pat. No. 1,679,285.

SALINOMETER, TEST AND GAUGE COCK. James D. Maxwell, Brooklyn, N. Y. Pat. No. 1,679,485.

INDICATOR GAUGE. Lino Scusa, Phoenix N. Y. Pat. No. 1,679,501.

MEASURING INSTRUMENT. Carl Gorham Hershey, El Paso, Texas, assignor to American Smelting & Refining Co. Pat. No. 1,679,524.

FABRIC MEASURING MACHINE. Harry T. Goss, Rutherford, N. J., assignor to Cossens Trading Co. Pat. No. 1,679,899.

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ELECTRO - MAGNETIC INSTRUMENT. Wilhelm Herzog, Charlottenberg, Germany, assignor to General Electric Co. Pat. No. 1,680,216.

TIME CLOCK INDICATOR. Franklin E. Crawford, Winchester, Mass., assignor to Bankers' Electric Protective Assn. Pat. No. 1,680,321.

TESTING DEVICE. James O. Lewis and Homer R. Pierce, Tulsa, Okla. Pat. No. 1,680,334.

TEMPERATURE CONTROL SYSTEM. Irvin G. Thomas, Mansfield, Ohio, assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,680,398.

THERMOSTATIC SWITCH. Howard D. Matthews, Mansfield, Ohio, assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,680,426.

THERMOSTATIC REGULATOR. August J. Mottlau, Pittsburgh, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,680,428.

ELECTRICAL MEASUREMENT INSTRUMENT. Carl T. Mason, East Orange, N. J., assignor to Tiffany Manufacturing Co. Pat. 1,680,465.

LIQUID LEVEL INDICATOR. S. Q. Shannon and Herman Page Randall, Los Angeles, Calif. Pat. No. 1,680,916.

PRESSURE OPERATED INSTRUMENT. Walter Henry Fitts, Foxboro, Mass., assignor to The Foxboro Company. Pat. No. 1,681,109.

TEMPERATURE REGULATION. Arthur J. Otto, Milwaukee, Wis., assignor to Johnson Service Co. Pat. No. 1,681,253.

APPARATUS FOR MEASURING VARIABLE FORCES. Josua Gabriel Paulin, Stockholm, Sweden. Pat. No. 1,681,309.

ELECTRICAL TESTING INSTRUMENT. George Berkeley Rolfe, London, England, assignor to Evershed & Vignoles. Pat. No. 1,681,367.

THERMOSTATIC CONTROL. Reuben S. Tice, Monterey, Calif., assignor of one-half to Arthur L. Holcomb, San Jose, Calif. Pat. No. 1,681,446.

WATER LEVEL INDICATOR. Raymond E. White, Newton, Mass., assignor to Steam Vehicle Corp. of America. Pat. No. 1,681,452.

LIQUID LEVEL GAUGE. Frank B. Smithe, New York, N. Y., assignor to F. L. Smithe Machine Co., Inc. Pat. No. 1,681,504.

LEAKAGE TESTING DEVICE. Raymond E. Miller, Wilkinsburg, Pa., assignor to The Westinghouse Air Brake Co. Pat. No. 1,681,551.

PROPORTIONATE METER. Frederick W. Connet, Providence, R. I., assignor to Builders Iron Foundry. Pat. No. 1,681,762.

ENGLISH PATENTS

ELECTRIC METERS. British Thomson-Houston Co., Ltd., Crown House, Aldwych, London, England. Pat. No. 289,252.

WEIGHING APPARATUS. International Business Machines Co., 112 Strand, London, England. Pat. No. 289,278.

SLIDING CALLIPER GAUGES. M. A. Borel, 14 Faubourg St., Etienne, Pontarlier, France. Pat. No. 289,299.

MEASURING PUMPS FOR PETROL, OIL, ETC. A. Ter Vehn, 2075 Rivadavia St., Buenos Aires, Argentine. Pat. No. 289,337.

ELECTRIC METERS. Landis et Gyr. Soc. Anon., 1 Hofstrasse, Zug, Switzerland. Pat. No. 289,375.

ELECTRIC METERS. Landis et Gyr, Soc. Anon., 1 Hofstrasse Zug, Switzerland. Pat. No. 289,374.

FLUID PRESSURE GAUGES. Electroflo Meters Co., Ltd., Abbey Park, Park Royal, London, England. Pat. No. 289,358.

ELECTRIC METERS. Landis et Gyr. Soc. Anon., 1 Hofstrasse, Zug, Switzerland. No. 289,426.

GYROSCOPIC APPARATUS, BOREHOLE CLINOMETERS. Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij and Straatman, 30 Carel van Bylandtlaan, The Hague, Holland. Pat. No. 289,460.

ELECTRIC METERS. Metropolitan-Vickers Electrical Co., 4 Central Bldgs., Westminster, England. Pat. No. 289,481.

ELECTRIC TESTS. L. H. Peter and Westinghouse Brake & Saxby Signal Co., Ltd., 82 York Rd., King's Cross, London, England. Pat. No. 289,538.

Pressure Regulation in Vacuum Distillations. G. H. Richter, Ind. Engg. Chem., July 1928, p. 682.

The needle valve from the base of a Tirill burner is made to serve as a pressure regulator—M.E.H.

Remote Control-Industry's Magic Carpet. D. H. Killefer, Ind. Engg. Chem., July 1928, pp. 683-686.

An interesting article reviewing various types of remote controls.—M.E.H.

Modified Scale for Pfund Color Grader for Use on Dark Sirups. J. J. Willaman, Ind. Engg. Chem., July 1928, p. 701.

A new scale for use with added glasses is described.—M.E.H.

Coke Tumbler Tests. A. R. Powell and D. W. Gould, Ind. Engg. Chem., July 1928, pp. 725-728.

A series of physical tests of coke have been made in a coke tumbler following a design suggested by W. A. Haven, and recently suggested for adoption by the A. S. T. M.—M.E.H.

Accelerated Tests for the Settling of Pigments in Paints. Sidney Werthan and R. H. Wien, Ind. Engg. Chem., July 1928, pp. 729-732.

Various factors affecting the settling rate or tendency are considered, accelerated tests based on these factors are described and mthods for examining the degree ahd nature of the settled cake are given.—M.E.H.

Degree of Wetting of Silica by Crude Petroleum Oils. F. E. Bartell and F. L. Miller, Ind. Engg. Chem., July 1928, pp. 738-742.

The adhesion tension of various crude oils against silica and of the relative oil-displacing abilities of different aqueous solutions are discussed and methods and apparatus for measurement are considered.—M.E.H.

A Micro Saybolt-Type Viscosimeter. Stuart M. Rogers and Linder R. Adkins Ind. Engg. Chem., July 1928, p. 742.

A metal viscosimeter taking 8.5 ml. of sample, is described and a diagram with dimensions is given.—M.E.H.

Composition of Vapors from Boiling Binary Solutions. D. F. Othmer, Ind. Engg. Chem., July 1928, pp. 743-746.

A simple, rapid method for the determination of the relation of the composition of a boiling binary solution and the vapors has been presented. A compact, inexpensive apparatus designed to give data of such accuracy as might be required in the design of distillation equipment, is described.—M.E.H.

Apparatus for the Micro-Determination of Dissolved Oxygen. Thomas G. Thompson and Robert C. Miller, Ind. Engg. Chem., July 1928, p. 774.

An apparatus requiring not more than 10 ml. of sample of solution and designed for the determination of dissolved oxygen in water, is described.—M.E.H.

A New Design of Apparatus for the Moving Boundary Method of Determining Transference Numbers. Edgar Reynolds Smith, Jl. Amer. Chem. Soc., July 1928, pp. 1904-1906.

A moving boundary cell in which the boundary may be returned to the starting point for a new determination any number of times is described. The measurements with this apparatus are independent of any tube calibration.—M.E.H.

The Catalytic Action of Neutral Salts. The Effect of Normal Alkali Sulfates on Alkali Acid Sulfates in the Ketonic Splitting of Ethyl Acetoacetate. E. A. Goodhue and H. L. Dunlap, Jl. Amer. Chem. Soc., July 1928, pp. 1916-1922.

An apparatus has been devised for accurately measuring the velocity of reactions at higher temperatures and over a long period of time with substances evolving a gas.—M.E.H.

A Method for the Measurement of Interfacial Tension of Liquid Systems. F. E. Bartell and F. L. Miller, Jl. Amer. Chem. Soc., July 1928, pp. 1961-1967.

A method based on the capillary tube principle was developed for the determination of the interfacial tension of liquid-liquid systems. Two somewhat different types of apparatus were constructed and are here described.—M.E.H.

Results of Practical Experience in Photoelectric Photometry. W. Little and C. Horn, Trans. I.E.S., April 1928, pp. 419-427.

The photoelectric cell photometer has proven thoroughly practicable and its many advantages have made it indispensible. They are in use at the Electrical Testing Laboratories on integrating spheres for the measurement of incandescent lamps on the spectrophotometer when measuring the transmission of light through filters and on the distribution photometer.

Developments in Photoelectric Photometers. C. Sharp and H. Smith, Trans. I. E.S., April 1928, pp. 428-451.

This paper summarizes the progress which has been made in developing photoelectric photometers at the Electrical Testing Laboratories. Four separate systems are described, all of which have been given practical application and have shown their adaptability to commercial photometry.

New Precision in Cosmic Ray Measurements; Yielding Extension of Spectrum and Indications of Bands. R. A. Millikan and G. H. Cameron, Phys. Rev., June 1928, pp. 921-930.

A method is described which leads to greatly increased precision in the measurement of capacities of the order of one electrostatic unit.—M.B.R.

WEIGHING APPARATUS. Maatschappij Tot Exploitatie van Apparaten en Octrooien Berjo Te's Gravenhage, The Hague, Holland. Pat. No. 289,541.

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A New Method of Damping the Oscillations of a Circular Compass. O. Martienssen, Phys. Zeits., May 15, 1928, pp. 295-300.

The method is described in the article.

A Compensated Electron—Tube Voltmeter. H. M. Turner, Proc. Inst. Radio Engrs., June 1928, pp. 799-801.

Circuit arrangement is given in the article.

A Simple Graphic Method for the Determination of Galvanometer and Fluxmeter Constants, With a Note on the Measurement of Intense Magnetic Fields. A. Ferguson and E. Irons, Proc. Phys. Soc. Lond., April 15, 1928, pp. 95-106.

This paper deals with methods for evaluating the principle construction constants of moving coil instruments by the graphical treatment of observations of logarithmic decrement and its variation with circuit resistance.

Standardization of Methods of Heterochromatic Photometry. A. H. Taylor, Trans. I.E.S., April 1928, pp. 361-382.

This paper presents experimental results of photometric tests of twelve color filters. Measurements were made by flicker photometer, using nine observers, and by spectrophotometer. The paper concludes with a proposal for a standardized method of procedure to be followed in heterochromatic photometry.—M.B.R.

Photometry and Watt Measurements of Incandescent Lamps on Ordinary A.C. Circuits. C. H. Sharp and E. D. Doyle, Trans. I.E.S., April 1928, pp. 383-390.

A circuit arrangement is presented whereby the lumens and watts or amperes of incandescent lamps may be measured on an ordinary A. C. circuit.—M.B.R.

A Photoelectric Cell Photometer. C. Deshler and H. Schroeder, Trans. I.E.S., April 1928, pp. 391-418

A method of photometry is presented, which substitutes an "electrical eye" for the human eye. The visual comparison of light sources, the photometer spot, and the working stand lamp have been entirely eliminated.—M.B.R.

Some Methods of Estimating the Intensities of Spectral Lines. W. Childs, Proc. Phys. Soc. Lond., April 15, 1928, pp. 132-148.

This paper presents a critical account of several methods of spectral photometry applied to the special case of the band spectrum of helium. Density measurements are obtained by a simply constructed selenium cell microphotometer.

Electrical Methods of Hygrometry. P. W. Burhidge and M. Alexander, Proc. Phys. Soc. Lond., April 15, 1928, pp. 149-155.

An account is given of experiments performed to investigate the possibility of applying electrical methods to the measurement of humidity. Two methods are considered, depending on 1) the change in resistance of organic materials on exposure to water vapor; 2) the change in mobility of ions due to water vapor.

Microscopical Investigation of Artificial Silk Fibers. L. G. Lawrie, J. Soc. Dyers Coloarists, March 1928, pp. 73-78.

Directions are given for preparation and mounting of artificial silk fibres for microscopical investigation. The characteristics of the various artificial silk fibres are given as examined under polarized light, also by transmitted light, reflected light, and by dark-ground illumination. Directions for cross-sectioning fibres are given, also for swelling of fibres.—Abs. Bull. Kodak Research Labs.

The Measurement and Calculation of pressure losses especially in the Open Hearth Furnace. (Messung und Errechnung der Druckverluste insbesondere in Sumens-Martin Oefen). W. Heil, Archir fuer das Eisenhuettenwesen, June 1928, pp. 729-740.

Pressure losses in pipes and critical consideration of the results of the investigation. The pressure losses in different sections of the open hearth furnace and criticism of the investigation results. Comparison of measured and calculated results.

Discharge Tube for photometric Measurements especially in the Ultraviolet. (Entladungsrohr fuer photometrische Messungen insgesondere in Ultraviolett). E. Lau, Zeits. Instrumentenk, June 1928, pp. 284-285.

A new tube is described briefly.

Development of Extensometers for Small Lengths. (Beitrag zur Entwicklung von Dehnungsmessern kleiner Messlaenge). K. Boettcher, Zeits. Instrumentenk, June 1928, pp. 285-292.

Continued from page 247. The following is taken up in this concluding installment; the systematic errors of the extensometer; calibration of the new extensometer; illustration of the use of the extensometer.

Standardization in Microscope Construction. (Zur Normalisierung im Mikroskophan). C. John, Zeits. Instrumentenk, June 1928, pp. 292-299.

The author makes a plea to microscope builders to standardize so that the parts of one manufacturer's microscope will be interchangeable with that of another. He compares in a table the following values of the following manufacturers: Zeiss Leitz, Reichert, Winkel, Seibert, Hemmler, Hartnack, Kremp, Busch and Voightlaender. Numerical aperture of the objective, focal length, enlargement of the objective and enlargement of the ocular.

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The Business Manager's Page

Each month the Business Manager will have a message on this page.

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THERE is no industry that does not profit enormously by measurement, testing and inspection of the materials as received and during the manufacturing process.

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Below are standard file cards, which the editor believes will be a valuable asset to you personally. These cards will be bound in each issue of Instruments and will cover the original articles contained in that issue. The color of the card and ink to be used is shown here. This will facilitate distinguishing the INSTRUMENTS FILE CARDS from others with which they might be consolidated.

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The card is arranged with a space for classification subject or number at the top. Suggestions as to classifications for the cards below are:

INSTRUMENT PIONEERS
PHOTO-ELASTIC STRESS DETERMINATION

INSTRUMENT PIONEERS—JOHN JACOB BAUSCH (1830-1926) AND CAPTAIN HENRY LOMB (1826-1908).

INSTRUMENTS, Vol. 1, No. 9, September 1928, pp. 389-392, 2 figs.

A brief history of these two men is given. It actually is a story of the Bausch & Lomb Optical Co.

DESCRIPTION OF A POLARIZED LIGHT APPARATUS FOR PHOTO-ELASTIC WORK.

R. V. BAUD, INSTRUMENTS, Vol. 1, No. 9, September 1928, pp. 393-400, 9 figs.

In this paper five different designs of polarized light arrangement for photo-elastic work are outlined and the action of Nicol prisms and mica plates is described.

Particular reference is given to the Coker apparatus as used in the Research Laboratory of the Westinghouse Electric and Manufacturing Company.

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TRANSVERSE TESTS ON ROUND AND SQUARE BARS OF GREY CAST IRON.

A. L. **NORBURY, D. Sc.,** INSTRUMENTS, Vol. 1, No. 9, September 1928, pp. 401-403, 1 fig.

This article is a reprint of a report of the British Cast Iron Research Association. It gives the results of an investigation to determine the difference in the modulus of rupture of square and round bars.

A NEW ENGINE INDICATOR.

MAX **HARTENHEIM,** INSTRUMENTS, Vol. 1, No. 9, September 1928, pp. 405-407, 2 figs.

This article points out certain advantages in a proposed design of an indicator recorder mechanism. The drum is replaced by a disc and the record will be in polar coordinates in place of the usual linear coordinates.

THE CALCULAGRAPH.

H. C. **DILSIZIAN,** INSTRUMENTS, Vol. 1, No. 9, September, 1928, pp. 409-412, 4 figs.

The use of the calculagraph in long distance telephone work is taken up. The construction of the instrument is shown.

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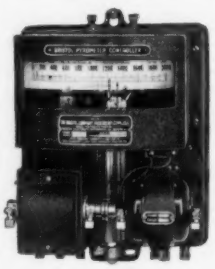

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